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Determining Input Variables for Calculation of Impact of New Source Performance Standards Worksheets for Metallurgical Industries

Research Corp. of New England, Wethersfield, Conn

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16. ABSTRACT
The purpose of this document is to present the results of a study to determine the impact of new source performance standards on nationwide emissions. The work presented covers 14 potential pollutants from approximately 200 source categories for the year 1985. The results are being used by EPA as input to the development of an overall standard setting strategy. The report contains information regarding controlled and uncontrolled emission factors, State emission limitations, industrial capacity, utilization, growth and retirement rates. The results of this study have been published as three volumes which encompass ten separate documents. This document contains Appendix 4E of Volume II - Calculation Sheets for the Metallurgical Industry.

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a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS		c. COSATI Field/Group
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EPA-450/3-76-018-e
April 1977

DETERMINING INPUT VARIABLES FOR CALCULATION OF IMPACT OF NEW SOURCE PERFORMANCE STANDARDS: WORKSHEETS FOR METALLURGICAL INDUSTRIES

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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EPA-450/3-76-018-e

DETERMINING INPUT VARIABLES FOR CALCULATION OF IMPACT OF NEW SOURCE PERFORMANCE STANDARDS: WORKSHEETS FOR METALLURGICAL INDUSTRIES

by

The Research Corporation of New England
129 Silas Deane Highway
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Contract No. 68-02-1382

EPA Project Officer: Gary D. McCutchen

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
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Research Triangle Park, North Carolina 27711

April 1977

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Publication No. EPA-450/3-76-018-e

FOREWORD

During 1974, two studies were initiated that ultimately resulted in the establishment of priorities for developing and promulgating New Source Performance Standards (NSPS). The procedures used to determine these priorities produced a great deal of information that is believed to be useful in the industries involved and, accordingly, is being published in this series of reports (EPA-450/3-76-017, EPA-450/3-76-018, EPA-450/3-76-019, and EPA-450/3-76-020). This information is organized as follows:

EPA-450/3-76-017 discusses (1) the mathematical model (Model IV) used to determine NSPS impacts over a 10-year period; (2) the methods used to attain input variables; and (3) the summary tables which are the heart of this study. Included in the summary tables are data related to (1) emission, growth, and replacement rates; (2) present and future production and capacity; (3) nationwide emissions; and (4) NSPS impact. These tables include information on 13 pollutants and nearly 200 stationary source categories.

EPA-450/3-3-76-018-a, -b, -c, -d, -e, and -f are the calculation sheets, showing how the input variables reported in EPA-450/3-76-017 were derived. All information sources, assumptions, and calculations are documented and explained. The appropriate worksheets are arranged alphabetically in the following volumes:

018-a - Stationary Combustion Sources
018-b - Chemical Processing Industries
018-c - Food and Agricultural Industries
018-d - Mineral Products Industries
018-e - Metallurgical Industries
018-f - Miscellaneous Sources (Evaporation Losses, Petroleum Industry, Wood Products Industry, and Assembly Plants

The 018-a -f series is of interest only to those concerned with the detailed calculations used to determine the Model IV input variables.

EPA-450/3-76-019-a provides additional results and information produced during the priority study. Its major purpose is to describe the computer program used to rank all the Model IV input and output variables by pollutant (these rankings are reported in 019-b and -c). In addition, it contains (1) summaries of the control systems considered "best" for each source, (2) equipment retirement ages, and (3) emission trends for each source category.

EPA-450/3-76-019-b and c present the computer-generated ranked data for each pollutant. Ranking is from highest to lowest for each of the 21 variables, e.g., A (nationwide capacity) and E_u (uncontrolled emission rate). Volume 019-b contains ranked data for particulate, nitrogen oxide (NO_x), and sulfur oxide (SO_x) sources. In Volume 019-c, the remaining pollutant sources are ranked: hydrocarbons, carbon monoxide (CO), fluorides, hazardous material, acid mist, lead, ammonia, sulfides, chlorine, and trace metals.

EPA-450/3-76-020, the final document in this series, takes the objective impact values from EPA-450/3-76-017, adds subjective judgements, and uses these combined criteria to produce a priority list for NSPS development. The report then calculates nationwide emission trends over the next 15 years for each criteria pollutant (particulate, SO_x, NO_x, hydrocarbons, and CO) based on a series of scenarios (e.g., no NSPS, 20 NSPS per year, etc.)

In summary, documents EPA-450/3-76-017 and 020 present the results of this study. Each stands alone, but they also complement each other, with 020 building on the results of 017. The remaining documents (018-a -f and 019-a -c) present additional and/or more detailed information derived from the impact and priority studies.

WORKSHEET
FOR
METALLURGICAL INDUSTRIES

TRC -- The Research Corporation of New England
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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-6-74

Source Primary Aluminum Smelters

electrolytic reduction of alumina (from bauxite)
electrolyte is Sodium Aluminum Fluoride : (cryolite)

largest source of pollutants is the potline Ref 035 p 4

K: Table 2.7 pg 2-25 in Ref 035 gives production-capacity data from which utilization factors may be obtained. The average K is evaluated for the period 1948 to 1969.

$$\frac{\Sigma K}{\text{No yrs}} = K_{avg} = \frac{20.14}{22} = .915$$

We will use K = .92 as representative of the normal utilization factor for the primary aluminum industry smelters.

$$\boxed{\therefore K = .92}$$

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 9-6-74

Source Primary Aluminum Smelters

P_c: Ref 035 pg 2-2

1965 - 1968 capacity increase average 8.4% /yr
1968 - 1969 " " " 5.5% /yr

Weighting the growth $\frac{3\times 8.4 + 5.5}{4} = 7.7\%/yr$

A: a conservative approximation will will use
$P_c = .075$ compound as applicable for 1975 - 1985

$$\boxed{P_c = 075 \text{ compound}}$$

A: Using the 1969 Capacity value of 3,888,000 Tons from Table 2.7 of Ref 035 and the growth of 7.5% ($P_c = .075\,c$) we estimate the 1975 Prod Capacity
n = 6 yrs

$$A = 3,888,000(1+.075)^6$$

$$\boxed{\therefore\ A = 6.00 \times 10^6 \text{ TON/yr aluminum}}$$

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Computation Sheet For Industrial Factors

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Source Primary Aluminum

ρ_B :

Ref 037 pg 34 Sec 33.2

Asset guideline life 14 yrs

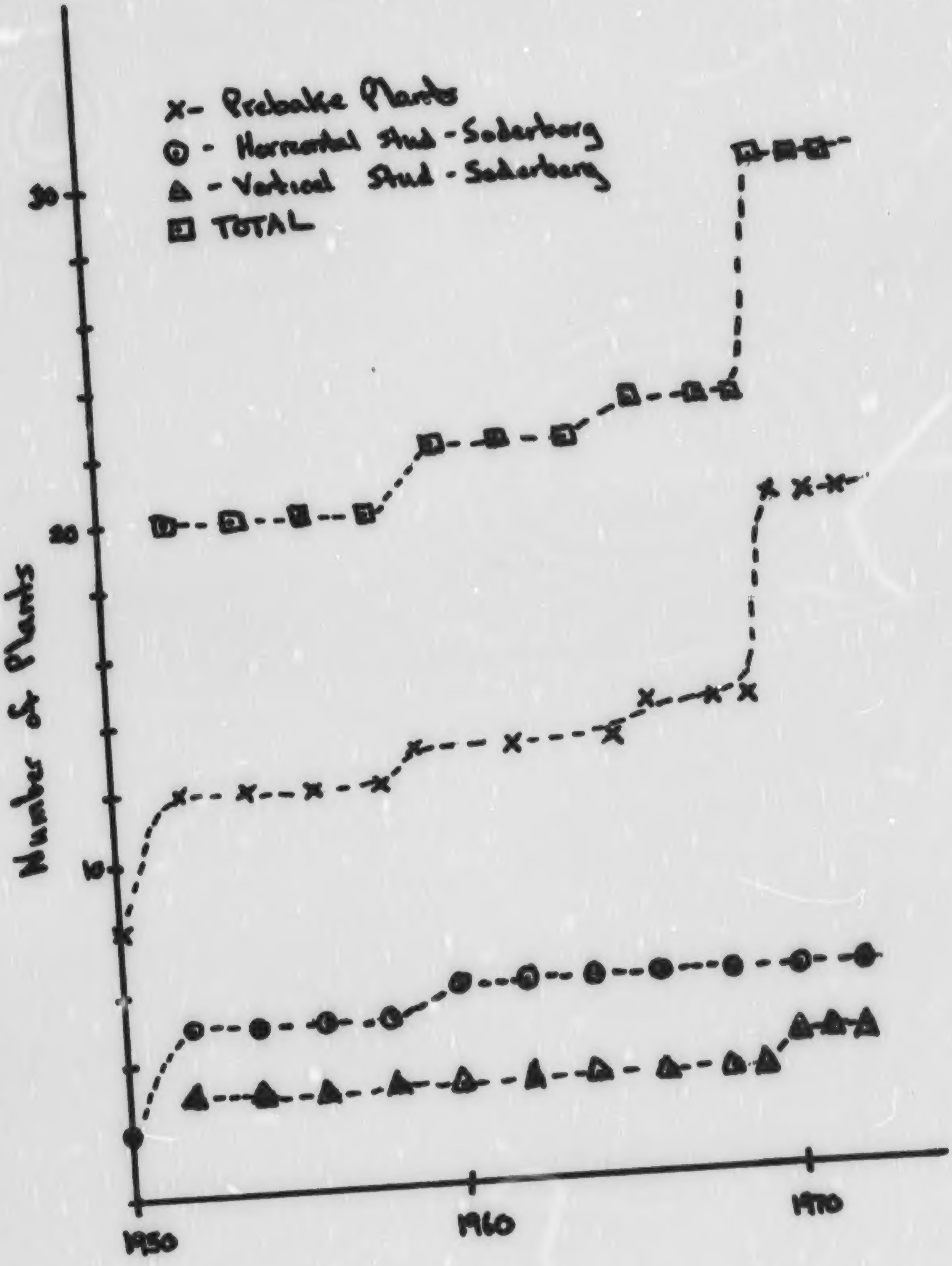
ρ_B est = 2×IRS = 28 yrs

100% Depreciation in 28 yrs $\frac{100}{28\,yr}\% = \underset{simple}{3.6\%}/yr$

We will use 3.5% as an estimate of the obsolescence rate.

$$\boxed{\therefore \rho_B = .035 \text{ simple}}$$

Primary Aluminum



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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-6-74

Source Primary Aluminum Smelting

E_u: Particulates

Ref 035 pg 4

Uncontrolled emission factor representative of all cell types (Prebaked & Soderberg)

$$E = 46 \text{ lb} / 1000 \text{ lb Al produced}$$

$$\therefore \; E_u = 2 \times 46 = 92 \text{ lb/TON Al}$$

This particulate emission is stated to be composed of a solid fluoride portion

$$9 \text{ lb Solid F} / 1000 \text{ lb Al} \Longrightarrow 18 \text{ lb/TON Al}$$

$$\text{Solid Fluoride Content} = \frac{18}{92} = .195 \text{ or } 19.5\%$$

We choose an uncontrolled emission factor to be based on total solids (including Solid F)

$$\boxed{\therefore \; E_u = 92 \text{ lb/TON Al.}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marzone Date 9-6-74

Source Primary Aluminum Smelting

Particulate

E_N: Refer to Ref 035 Table 5.2a pg 5-14

highest reported Pt removal eff - 98%
which includes solid fluoride

We use this for E_N determination
of particulate emission

$$E_N = .02 \times E_u = .02 \times 92 \text{ lb/TON}$$
$$= 1.8 \text{ lb/TON}$$

FLUID BED DRY SCRUBBER
COATED FILTER DRY SCRUBBER
INJECTED ALUMINA DRY SCRUBBER

$$\therefore E_N = 1.8 \text{ lb/TON Aluminum}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-6-74

Source Primary Aluminum Smelting

Hydrocarbons :

Ref 035 pg 4

Hydrocarbon emissions are attributable to Soderberg cells as appoed to the Prebaked Potline Cells.

pg 3-16 of the above source indicate that the larger number of installations are of the pre-backed version, and moreover, expansion and construction in the Soderberg cells has not been significant nor do we expect this trend to change. Operating problems and control requirements encourage the use of pre-baked potline.

We conclude that HC emissions from this industry would not come under NSPS

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-6-74

Source Primary Aluminum Smelter

Sulfur Oxides

E_u: Ref 035 pg 4 and pg 4-8

$$E_u = 30 \text{ lb}/1000 \text{ lb Al}$$

or

$$2 \times 30 = 60 \text{ lb/TON Al}$$

$$\therefore \boxed{E_u = 60 \text{ lb/TON Al}}$$

Sulfur in carbon anodes is responsible for SO_x emissions Petroleum coke of 2.5-5.0 %S content is basis of carbon anode production

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 9-6-74

Source Primary Aluminum Smelter

E_N: Sulfur Oxides

Ref 035 pg 10-17 states that "removal of SO_2 from aluminum plants present a difficult problem because of low concentration in the gas stream."

For the sake of this study until SO_x control becomes evident, we assume $E_N = 0$ which represents maximum impact $(T_S - T_N)$

$$\boxed{\therefore E_N = 0}$$

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Computation Sheet For Emission Factors

Calculations Done By W. [illegible] Date 9-6-74

Source Primary Aluminum Smelter

E_u:

Fluorides

Ref. 035 pg 4

	Uncontrolled Emissions
Solid F	9 lb/1000 lb Al
Gaseous F (as HF)	14 lb/1000 lb Al
Total F	23 lb/1000 lb Al
	or 46 lb/TON Al

The uncontrolled emission will be considered to represent the total F emission of which

61% is gaseous
39% is solids

Note also that the solid F was included in the particulate emission and represented 19.5% of it.

$$\therefore \boxed{E_u = 46 \text{ lb/TON Al}}$$

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Computation Sheet For Emission Factors

Calculations Done By R. Massarone Date 9-6-74

Source Primary Aluminum Smelter

E_N: **Fluorides**

Ref 160 pg 1-5

NSPS for new smelters 2 lb/ton Al (total F)

$$\boxed{\therefore E_N = 2\ \text{lb/ton Al (Total F)}}$$

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Computation Sheet For Emission Factors

Calculations Done By V.F. Russo Date 10/18/74

Source Primary Aluminum Smelters

Particulates:
Ref 035, pg 2-2 states that

2 lbs of Bauxite yeilds 1lb. of Alumina (Al_2O_3)
Using 100 % efficency of Electrolytic Cells
1 lb of Al_2O_3 geilds $\frac{2(27)}{102}$ lbs of Al
or

2 lbs of Bauxite yeilds 0.52 lbs of Al.
1 lbs of Bauxite yeilds 0.26 lbs of Al

Ref. 035 pg 2-22 gives plant locations and capacity for 1970. We will find average (output) capacity for plants in state, get (average) process weight, multi. this output process weight by 3.84 to get it in terms of input process weight and their get the allowable emissions for this input process weight.

i.e. 3.84 lbs Bauxite yeilds 1 lbs. of Al.

Ref. 093 pg 250 lists actual ~~not~~ figure as 3.82 lbs Bauxite => 1 lbs Al.

This procedure yeilds an E_s which assumes that the 1975 production capacity is distributed in the stated states as the 1970 capacity with the same relative capacities. Also, this procedure assumes the size of any new plants is the same in 1975 as the average plants capacity in 1970.

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Computation Sheet For Emission Factors

Calculations Done By V.F. Russo Date 10/18/74

Source Primary Aluminum Smelters

State	N_p^i	Output 1970 Cap. (10^3 T/YR)	Input Process Wt (lbs/HR)*	Plant Allowable Emissions (lbs/HR.)**
✓Tenn	2	340	149,000	34
✓NC	1	100	88,000	43.4
✓Ind.	1	225	197,250	46
✓N.Y.	2	253	110,900	51
✓Texas	3	561	163,950	90
✓Mont.	1	175	153,400	47
✓Ky.	1	90	78,890	41.5
✓Oreg.	2	228	99,950	44.5
✓La.	1	260	227,950	51
W. Va.	1	163	142,900	48
✓Ohio	1	240	210,400	50
✓Ark.	2	185	81,100	31
✓Md.	1	85	74,500	41.9 ***
✓Ala.	1	221	193,750	33 ++
Wash.	6	1016	148,500	15 lbs/Ton AL *+

* For average plant capacity by $\dfrac{\text{Output Cap}(\frac{\text{lbs}}{\text{YR}}) \times 3.84}{N_p^i \quad 8760(\frac{\text{HRS}}{\text{YR}})}$

** Ref. 084 & 148

++ For Class I counties

*+ State has specific reg. for Al Smelters.

*** For Eastern, Southern, Central, Cumberland-Keyser Regions

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Computation Sheet For Emission Factors

Calculations Done By V.F. Russo Date 10/18/74

Source Primary Alum. Smelters

Thus

State	A_i	$E_s^o \left(\frac{\text{lbs part}}{\text{TON AL}}\right)^*$	$A_i E_s^o \left(\frac{\text{lbs part.}}{\text{TON AL}}\right)$
Tenn.	.08	1.752	.140
NC	.02	3.802	.076
Ind.	.05	1.791	.090
N.Y.	.06	3.532	.212
Texas	.14	4.216	.590
Mont.	.04	2.353	.094
Ky	.02	4.040	.080
Oreg.	.06	3.419	.205
La.	.06	1.718	.103
W.Va	.04	2.580	.103
Ohio	.06	1.825	.109
Ark	.04	2.936	.117
Md.	.02	4.318	.086
Ala.	.05	1.308	.065
Wash	.25	15	3.750

*Calculated using $\frac{N_p^i \left(\text{Allow. Emiss } \frac{\text{lbs}}{\text{HR}}\right) 8760 \left(\frac{\text{HRS}}{\text{YR}}\right)}{\text{Output Prod. Cap. } \left(T/\text{YR}\right)}$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By U.F. Russo Date 10/18/74

Source Primary Alum. Smelters

$$E_s = \sum A_i E_s^o$$

$$\boxed{E_s = 5.820 \text{ lbs Part.}/\text{TON AL.}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By V.F. Russo Date 10/21/74

Source Primary Alum. Smelters

SO_2 Emissions

Only two states have SO_2 regulation applicable for primary Aluminum Smelters (Ref. 084 and 148)

Ind : $E_p(\#SO_2/hr) = 19.5\ P(TONS/HR)^{0.67}$

La. : Max. emission concentration 2000 ppm

For Indiana, as previously shown,

Input Process Wgt (lbs/hr) = 197,250

or

Process Wgt = 98.625 TONS/HR

Thus, the allowable SO_2 emissions are

$$E_p(\#SO_2/hr) = 19.5\,(98.625)^{.67}$$

$$\simeq 423$$

For Ind. $E_p = 423\ \#SO_2/hr$

or

$$E_s^o = \frac{423\ \#SO_2/hr\ (8760\ HR/YR)}{225 \times 10^3\ Tons\ AL/YR}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By V. F. Russo Date 10/21/74

Source Primary Alum. Smelters

$$E_S^{\circ} = 16.5 \frac{\text{lbs } SO_2}{\text{TON AL}}$$

For La, neglecting Bake cells and considering only potline effluents.

~~[illegible]~~

Journ. Air Poll. Control. Assoc. (Feb. 1973) 23, #2 pg 101 gives

SO_2 emissions as 90 - 300 mg/m³

Taking average of 195 mg/m³

The potline effluents (in ppm) becoms (assuming emission at standard conditions)

$$10^6\left(\frac{\text{moles } SO_2}{\text{moles Gas}}\right) = \frac{\frac{.195 \text{ gms}}{64 \text{ gms/mole}}}{\frac{1000 \text{ liters}}{22.4 \text{ liters/mole}}} \times 10^6 = 68.25 \text{ ppm}$$

Thus, emissions are below standard.

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Computation Sheet For Emission Factors

Calculations Done By V.F. Russo Date 10/21/74

Source Primary Alum. Smelting

$$\text{or } E_s = (\text{Emission for Ind.})\,A_i + (1.00 - A_i)\,E_u$$

$$\therefore\ E_s = 16.5\,(.090) + (0.91)\ 60$$

$$E_s = 1.485 + 54.6$$

$$\boxed{E_s = 56.09\ \frac{\text{lbs } SO_2}{\text{TON AL.}}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-31-74

Source Primary Aluminum Smelter

E_{111d}: Fluorides

Ref 160 pg 1-12

Recommended standards (for States) of Existing Primary Aluminum Plants

Cell Type	Standard lb/ton Al
Vertical Stud Soderberg	3
Horizontal Stud Soderberg	3
Centerwork Prebaked	4
Sidework Prebaked	2
Avg	3 lb/ton Al

We assume this average typical of emission limitations to be set on all existing primary aluminum plants.

$\therefore E_{111d} = 3$ lb/ton Al

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 2-7-75

Source Primary Aluminum Smelter

E_s: Fluoride

Of the states having aluminum production capacity only Oregon and Washington specify fluoride regulations applicable to Aluminum (Primary) Production. Montana's Fluoride regulation excludes primary aluminum plants.. Washington gives ambient and forage quality standards and doesn't specify emission levels. Oregon gives emission rates for new and-existing plants in terms of total fluoride.

Since fluoride emissions from this industry are in the form of both gaseous and solid constituents then at least a part of it (solid) will be "defacto" controlled by particulate regulation in those state with no fluoride regulation

In developing a synthesized value of E_s for this pollutant we make the following assumptions

① Oregon Reg for new : 2.0 lb F / TON alum
Existing : 2.5 lb F / TON alum

② Washington ambient air quality will be dotained by average controlled plant which is assumed to be at 85% level on Total Fluoride

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 2-7-75

Source Primary Aluminum Smelter

E_5 : Fluoride contd

③ Solid Fluoride controlled in remaining states by PWR curve (19.5% of Pt E_u is solid Fluoride)

④ Gaseous Fluoride is uncontrolled in all states except Oregon and Wash.

⑤ E_5 will be calculated by weighting allowable emissions by capacity occurrence.

⑥ New and Existing E_5 will be determined to reflect Oregons new and existing regulation

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-7-75

Source Primary Aluminum Smelting

		← Allowable Emission lb/ton Al →			Ai × TOTAL	lb/ton Al
State	**Ai**	**Solid**	**Gaseous**	**Total**	**Exist**	**New**
Tenn	.08	.34	28	28.34	2.267	2.267
NC	.02	.74	28	28.74	.575	.575
Ind	.05	.35	28	28.35	1.418	1.418
NY	.06	.69	28	28.69	1.721	1.721
Texas	.14	.82	28	28.82	4.035	4.035
Mont	.04	.46	28	28.46	1,138	1.138
Ky	.02	.79	28	28.79	.576	.576
Oreg	.06	—	—	1.0 New, 2.5 Exists	.150	.060
La	.06	.34	28	28.34	1.700	1.700
W Va	.04	.50	28	28.50	1.140	1.140
Ohio	.06	.36	28	28.36	1.702	1.702
Ark	.04	.57	28	28.57	1.143	1.143
Md	.02	.84	28	28.84	.577	.577
Ala	.05	.26	28	28.26	1.413	1.413
Wash.	.25	—	—	6.9	1.725	1.725
				$E_s' = \Sigma =$	19.013	18.923

Diff ≈ .09 lb/ton

Since E_s (exist & New) differ by only .09 lb/ton we will develop only one E_s factor so that $E_s \approx 19$ lb/ton

E_s (Fluoride) = 19 lb/TON Al produced

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-4-74

Source Beehive Coke Ovens

Ref 050 "By Product Coke ovens pg 1

In 1971 the production capacity for beehive coke ovens was about 500,000 TON/yr and it was indicated that no new beehive plants were anticipated to be built in the near future. This implies that the 1975 Prod. Cap. would be equivalent to the 1971 value and that the growth in the industry is nil

A:

$$\boxed{\therefore\ A = .5 \times 10^{6}\ \text{TON/yr coke}}$$

P_c:

$$\boxed{\therefore\ P_c = 0}$$

K:

Assume capacity utilization factor for beehive ovens to be the same as for byproduct ovens $\therefore$ K=.93

$$\boxed{K = .93}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-4-74

Source Beehive Coke Ovens

P_B : The growth in this industry, as indicated above, is not expected to be positive. It may very well have a negative growth rate.

This oven has had a decreasing share of the production and Ref 097 pg 87 identifies this source as an obsolete process. which would be best controlled by replacement with by-product coke plants.

We are assuming that; not only are no new coke plants being built ($P_C=0$) but that existing capacity will not be replaced on obsolecence by other beehive ovens. This implies that $P_B = 0$

$$\boxed{\therefore P_B = 0}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-4-79

Source Beehive Coke Ovens

The coke produced from the coal charged for beehive oven is estimated from the values appear in Ref 049 Table 9-2 pg 120

$$\frac{775{,}000 \text{ TON COKE}}{1{,}300{,}000 \text{ TON COAL}} \Longrightarrow \frac{775{,}000}{1{,}300{,}000} = .596 \frac{\text{Ton coke}}{\text{Ton coal}}$$

We obtain uncontrolled emission factors from Ref 075 Table 7.2-1 pg 7.2-2

Particulate

$$E_u = 200 \frac{\text{lb}}{\text{TON coal}} \times \frac{\text{TON coal}}{.596 \text{ TON coke}} \cong 336 \frac{\text{lb}}{\text{TON coke}}$$

$$\boxed{\therefore E_u = 336 \text{ lb/TON coke}}$$

Carbon Monoxide

$$E_u = 1 \frac{\text{lb}}{\text{TON coal}} \times \frac{\text{TON coal}}{.596 \text{ TON coke}} \cong 1.7 \text{ lb/TON coke}$$

$$\boxed{\therefore E_u = 1.7 \text{ lb/TON coke}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-4-74

Source Beehive Coke Ovens

Hydrocarbons

$$E_u = 8 \frac{\text{lb}}{\text{TON coal}} \times \frac{\text{coal}}{.596 \text{ coke}} \doteqdot 13.4 \text{ lb}/\text{TON coke}$$

$$\boxed{\therefore E_u = 13.4 \text{ lb}/\text{TON coke}}$$

Ammonia

$$\boxed{E_u = 2 \frac{\text{lb}}{\text{TON coal}} \times \frac{\text{coal}}{.596 \text{ coke}} \approx 3.4 \text{ lb}/\text{TON coke}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 5-9-75

Source Beehive Coke Ovens

Ref 274 pg 32 describes hydrogen sulfide emissions from byproduct coke ovens however, in light of the lack of other data we will approximate that the production of H_2S for beehive oven will be somewhat equivalent

Emission = 6.7 lb/TON coal charged

$$6.7 \frac{\text{lb}}{\text{TON Coal}} \times \frac{\text{Ton coal}}{.596 \text{ Ton coke}} \cong 11.2 \text{ lb/TON coke}$$

$$\boxed{E_u (\text{sulfide}) = 11.2 \text{ lb/TON coke}}$$

Since this source has values of $P_C = 0$ and $P_B = 0$ it is probably that NSPS would not be set for this industry.

Section 111d may still be imposed on the non-criteria pollutants, therefore we will develop the factors E_S E_N and E_{111d} for ammonia and sulfide.

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 5-9-75

Source Beehive Coke Ovens

E_s: Ref 84 & 148 There are no specific regulations for ammonia and sulfides so that we may assume the relationship $E_s = E_u$

$$E_s(\text{ammonia}) = 3.4 \text{ lb/TON coke}$$

$$E_s(\text{sulfide}) = 11.2 \text{ lb/TON coke}$$

As discussed in Ref 097 pg 87 there is no reasonable control method for beehive coke ovens.

"The only practical control method is to replace the ovens with well-designed slot-type ovens with by-product gas recovery systems."

We were unable to obtain specific controls for this source and suspect that little may be done in tune with the economics of this industry.

For max impact assessment we will assume $E_N = 0$ and $E_{IIId} = 0$ for both ammonia and sulfides.

$$E_N(\text{sulfide}) = 0$$

$$E_{IIId}(\text{sulfide}) = 0$$

$$E_N(\text{ammonia}) = 0$$

$$E_{IIId}(\text{ammonia}) = 0$$

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 9-4-74

Source By Product Coke Ovens

K: Using the data obtained from Ref 050 "By Product Coke ovens" pg 2 and illustrated on the attached graph we are able to calculate utilization factor estimates for the years 1970 through 1977

$K_{70} = \frac{67.4}{72.2} = .934$

$K_{71} = \frac{67.9}{72.2} = .940$

$K_{72} = \frac{68.4}{74.2} = .922$

$K_{73} = \frac{68.8}{74.9} = .919$

$K_{74} = \frac{69.2}{75.0} = .923$

$K_{75} = \frac{69.5}{75.5} = .920$

$K_{76} = \frac{69.6}{75.5} = .922$

$K_{77} = \frac{69.7}{75.5} = .923$

$$K_{Avg} = \frac{7.475}{8} = .934$$

We will use K = .93 and assume it representative of byproduct coke ovens and applicable for 1975-1985

$$\boxed{\therefore K = .93}$$

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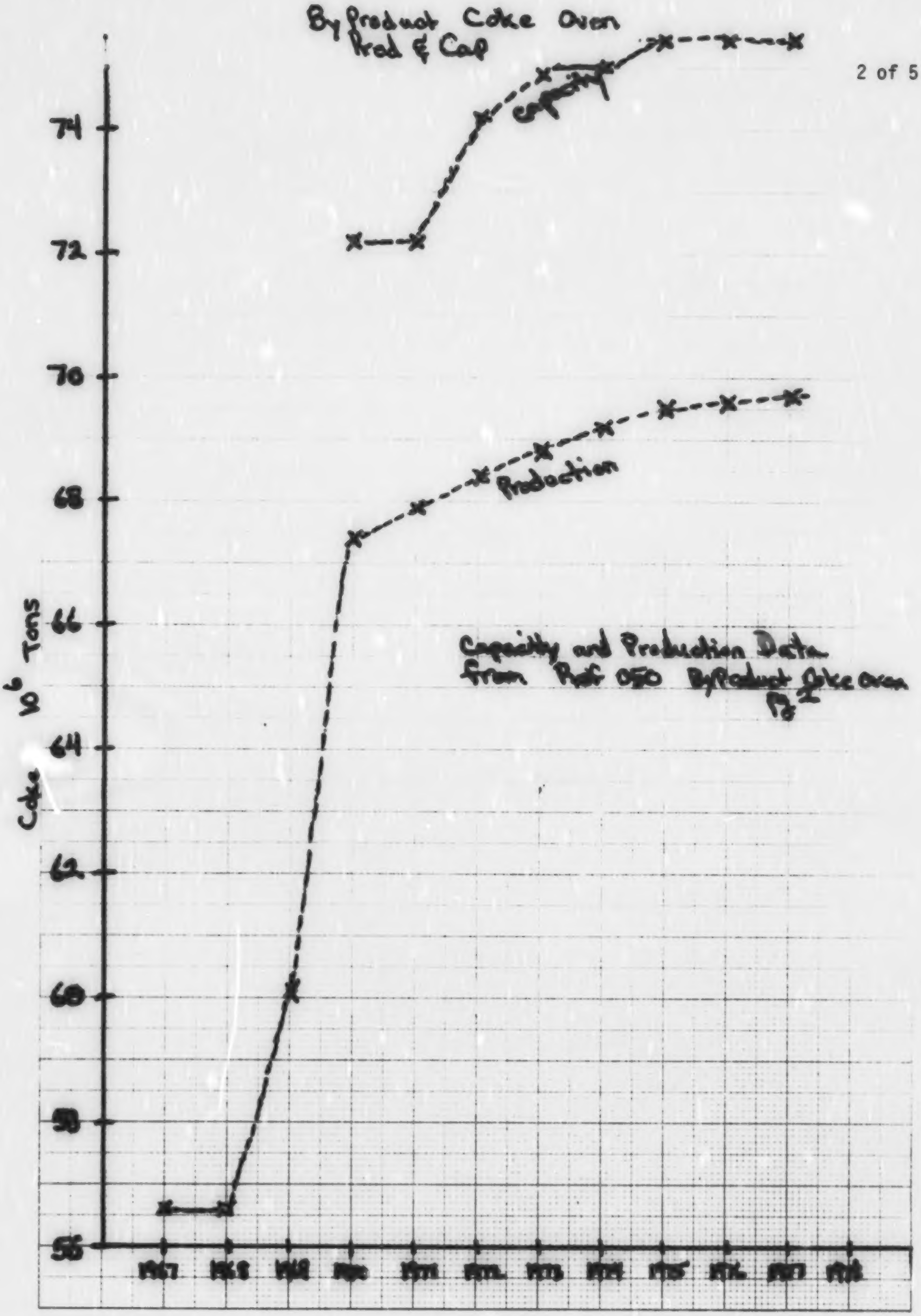
By Product Coke Oven
Prod & Cap
capacity
Production
Capacity and Production Data
from Ref 050 ByProduct Coke oven
Pg 2
Coke 10^6 Tons
74
72
70
68
66
64
62
60
58
56
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978

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Computation Sheet For Industrial Factors

Calculations Done By W Marrone Date 9-4-74

Source By-Product Coke Oven

A: The 1975 Production capacity is estimate in Ref 050 "Byproduct Coke ovens pg 2 to be 75.5×10^6 TON/yr

$$\boxed{\therefore A = 75.5 \times 10^6 \text{ TON/yr}}$$

According to Prod. Capacity figures in 1971 for beehive and byproduct coke ovens from the above source;

$$\frac{72.2}{72.2+.5} \cong .993$$

over 99% of coke production capacity is attributable to byproduct coke ovens.

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-4-74

Source By product coke oven

P_c : The growth of this industry will be directly guided by trends and practices in the steel making plants which consume roughly 90% of the coke production

Looking at the capacity data from Ref 050 pg2 which is plotted on the attached graph we see that there is a definite leveling of the production capacity. The estimated level is identical (75.5×10^6 T/yr) for the period 1975-1977

This implies a negligible growth indication for the industry. True growth predictions for coke were not obtained in the literature.

The simple growth rate from 1970 to 1975 obtained from the data in Ref 050 p2 was found to be;

$$\frac{75.5-72.2}{75.5} \times 100 \approx 4.37\% \text{ or } .87\%/yr$$

We make the assumption that a simple growth rate of 1% is representative for the by product coke ovens especially in light of little growth 1975-1977. Steel consumption which should guide coke demand is estimated by Ref 146 p73 is predicted to grow a 3%/yr. It is uncertain whether or not this value includes imports. In all it appears that the 1% growth is adequate.

$$\boxed{\therefore P_c = .01 \text{ simple}}$$

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Computation Sheet For Industrial Factors

Calculations Done By 21 Marrone Date 9-4-74

Source By Product Coke Ovens

P_B :

Ref 037 pg 34 Section 33.0

Asset guideline period 18 yrs

P_B est → 2×IRS = 36 yrs

$\frac{100\%}{36yr} \cong 2.8\%/yr$ simple 100% Depreciation in 36 years.

$\therefore P_B = .028$ simple

Plant locations in Ref 050

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-4-74

Source By Product Coke Ovens

The coke produced from the coal feed is estimated from data in Ref 049 Table 9-2 pg 120

$$\frac{63{,}700{,}000 \text{ TON coke}}{90{,}000{,}000 \text{ ton coal}} \Rightarrow \frac{63.7}{90.0} \approx .708 \; \frac{\text{TON coke}}{\text{TON coal}}$$

E_u:

Ref 075 Table 7.2-1

emissions given in terms of lb/TON coal charged we divide these value by ≈ .71 to obtain the emission factor in terms of lb/TON coke produced.

lb/TON COKE

Operation	Pt	SOx	CO	HC	NOx	NH_3
Unloading	.56	—	—	—	—	—
Charging	2.11	.03	.85	3.52	.04	.03
Coking Cycle	.14	—	.85	2.11	.014	.085
Discharging	.85	—	.01	.28	—	.14
Quenching	1.27	—	—	—	—	—
Underfiring	—	5.63	—	—	—	—
Total	4.93	5.66	1.71	5.91	.054	.255

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-4-74

Source By product Coke Ovens

E_u: cont'd

	E_u lb/TON coke produced
Particulate	4.9
SO_x	5.7
CO	1.7
HC	5.9
NO_x	.054
NH_3	.26

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-3-74

Source By product Coke Oven

E_N:

Ref 050 Byproduct coke ovens pg 6

"There are no well controlled plants either in the U.S. or elsewhere."

"The major effort in the US at this time is to use good operating and maintenance techniques until a control system has been proved"

Efforts are being investigated to control the three most significant sources of pollutants;

① charging
② pushing
③ quenching

Alternatives range from improved oven design, to add-on control systems and process modification.

The following are some of the controls proposed or being investigated:

① control of coal feed flow during charging to permit exhaust pickup for byproduct system

② operating at proper oven temp for a proper coking time may eliminate most emissions during pushing

③ hooding of hot coke car during pushing (Ford has a system which is reported to be working well)

④ scrubbers may be applied to larry-car during charging

⑤ baffle quench towers may reduce Pt. emissions during the coke quench operation

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Computation Sheet For Emission Factors

Calculations Done By 2) Marrone Date 10-3-74

Source By product Coke Oven

E_N: cont'd

⑥ dry quenching (now done in Europe) is a relatively new system which may be one solution

⑦ The by-product recovery plant can remove most of the cyanides, phenols, sulfur, tars, ammonia, and organic compounds.

The impact of this industry will certainly depend on the level of control that may be achieved. A high value for $T_S - T_N$ would be indicative of a sizeable control on this industry.

We choose at this point to treat E_N for this industry in two ways; (1) assume levels of control for applicable operations and pollutants and synthesis values of E_N; (2) set all pollutants $E_N = 0$ whereby we would be flagging this industry (Max $T_S - T_N$) as a source of emission with no demonstrated or state-of-the-art control technology. The value of $T_S - T_N$ will determine the relative importance of control developments to this industry.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-3-74

Source By Product Coke Oven

E_N cont'd

(1) Application of Controls

Assumptions made:

ⓐ control of pt emission during unloading is within normal collection technology - baghouse system 99% eff

ⓑ charging control schemes will ultimately achieve 90% eff for particulates. HC and NH_3 will be pickup and 99% control in byproduct recovery.

ⓒ discharging (pushing) controls will ultimately achieve 90% eff. for particulates. HC and NH_3 will be picked up by byproduct recovery with 99% control eff.

ⓓ Quenching will be controlled to the extent of 90% with respect to Particulates

ⓔ The emissions emanating from the coking cycle will be handled by the by product recovery plant to the extent of 99% for H_2S, HC NH_3 pollutants. This appears to be within current technology!

lb/TON coke produced

Unloading

Pt $E = .01 \times .56 \cong .006$

Charging

Pt $E = .1 \times 2.11 \cong .21$

SOx $E = E_u = .03$

CO $E = E_u = .85$

HC $E = .01 \times 3.52 = .035$

NOx $E = E_u = .04$

NH_3 $E = .01 \times .03 = .0003$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-3-74

Source By product Coke Oven

E_N: cont'd

Coking Cycle

Pt $E = .01 \times .14 \cong .001$

CO $E = E_u = .85$

HC $E = .01 \times 2.11 = .021$

NO_x $E = E_u = .014$

NH_3 $E = .01 \times .085 = .0009$

Discharging

Pt $E = .1 \times .85 = .085$

CO $E = E_u = .01$

HC $E = .01 \times .28 \cong .003$

NH_3 $E = .01 \times .14 \cong .001$

Quenching

Pt $E = .1 \times 1.27 \cong .13$

Underfiring

SO_x $E = E_u = 5.63$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By ______________________ Date ______________

Source ____

E_N "Appcation of controls" Cont'd

Summary

Operation	PT	SO_x	CO	HC	NO_x	NH_3
Unloading	.006	—	—	—	—	—
Charging	.21	.03	.85	.035	.04	.0003
Coking Cycle	.001	—	.85	.021	.014	.0009
Discharging	.085	—	.01	.003	—	.001
Quenching	.13	—	—	—	—	—
Underfiring	—	5.63	—	—	—	—
Totals ≈	.43	5.63	1.7	.06	.054	.002

∴

	E_N lb/TON coke
Particulate	.43
SO_x	5.63
CO	1.7
HC	.06
NO_x	.054
NH_3	.002

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 10-3-74

Source By Product Coke Ovens

E_N cont'd

(2) Maximum $T_S - T_N$ impact

	E_N lb/TON coke
PT	0
SO_x	0
CO	0
HC	0
NO_x	0
NH_3	0

6-11-75 WAM

For the purposes of this report the impact value $T_S - T_N$ or $T_S - T_{ND}$ will be based on actual values of E_n and E_{IId} not $E_N = E_{IId} = 0$.

except that there clearly is nothing demonstrated in the way of NO_x or CO control so we will keep these at maximum impact determination $E_N = 0$

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 10-15-74

Source By-Product Coke Ovens

E_u: Hydrogen Sulfide

E_u Ref 153 pg 51

E_u = 6.7 lb H_2S / TON coal charged

applying .71 $\frac{\text{TON coke}}{\text{TON coal}}$ as before

$$\boxed{E_u = \frac{6.7}{.71} \cong 9.4 \text{ lb/TON coke}}$$

E_N:

Cooling & scrubbing have been cited Ref 153 pg 51
50% control

$$E = .5 \times E_u = .5 \times 9.4 \text{ lb/TON coke}$$

$$\boxed{E_N = 4.7 \text{ lb/TON coke}}$$

maximum impact $E_N = 0$

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Computation Sheet For Emission Factors

Calculations Done By 2J. Marrone Date 6-11-75

Source By product Coke Oven

E_{111d} : NH$_3$ & H$_2$S E_S

NH$_3$ It is assumed that recovery plant control on NH$_3$ may be applied to existing source so that

$$\boxed{E_{111d} = E_N = .002 \text{ lb/TON coke}}$$

H$_2$S Control by cooling and scrubbing of H$_2$S is assumed feasible for existing plant to the same extent as a new plant.

$$\boxed{E_{111d} = E_N = 4.7 \text{ lb/TON coke}}$$

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Computation Sheet For Emission Factors

Calculations Done By JJ Marrone Date 10-18-74

Source By product Coke Ovens

E_s : Particulates

Ref 050 "ByProduct coke Plants" pg 1

1971	Production Capacity	72.2×10^6 T/yr	
"	Plants	69	
"	No of States	20	West, Midwest, North Central, South, East, and Northeast.
"	No of Ovens	14,895	

Using this information along with .71 lb coke/lb coal we may calculate the process input weight rate. We assume 8400 hr/yr of operation $\left(24\frac{hr}{d} \times 350\frac{d}{yr}\right)$

$$\frac{72.2 \times 10^6 \frac{\text{TON coke}}{\text{yr}}}{14{,}895 \text{ ovens}} \times \frac{2000 \text{ lb coke}}{\text{TON coke}} \times \frac{\text{lb coal}}{.71 \text{ lb coke}} \times \frac{\text{yr}}{8400 \text{hr}} \cong 1{,}625 \frac{\text{lb coal}}{\text{hr}}$$

process weight rate per oven

Since 20 of the 50 states are represented and the makeup spans the different regions of the country and population/size categories we will use the "50-state Process weight curve to estimate the allowable emissions.

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By 2W. Marrone Date 10-18-74

Source Byproduct Coke Ovens

E_s: Particulate cont'd

$$\text{Allowable Emission} = 3.55 \frac{\text{lb pt}}{\text{hr}} \quad \text{per oven}$$

$$E_s = \frac{3.55 \frac{\text{lb pt}}{\text{hr oven}} \times 8400 \frac{\text{hr}}{\text{yr}}}{\frac{72.2 \times 10^6 \frac{\text{TON coke}}{\text{yr}}}{14,895 \text{ ovens}}} \cong 6.2 \frac{\text{lb pt}}{\text{TON COKE}}$$

Since the value of $E_s > E_u$ we use the value of E_u in impact calculations $E_s = E_u = 4.9 \frac{\text{lb}}{\text{TON}}$

$$\boxed{\therefore E_s = 4.9 \frac{\text{lb}}{\text{TON COKE}}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-18-74

Source By product Coke Oven

cont'd

There are no state regulations (Ref. 084 & 148) which are applicable to Byproduct Coke ovens for SO_x, CO, HC, NO_x, NH_3, and H_2S.

We therefore assume $E_s = E_u$

E_s SO_x = 5.7 lb/TON COKE

E_s CO = 1.7 lb/TON COKE

E_s HC = 5.9 lb/TON COKE

E_s NO_x = .054 lb/TON COKE

E_s NH_3 = .26 lb/TON COKE

E_s H_2S = 9.4 lb/TON COKE

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Copper

Basically, there are three operations at copper smelting plants
ⓐ Roasting
ⓑ Smelting
ⓒ Converting

Ref 029 p 3.1-1

In 1973 8 of the 15 primary copper smelters do not perforom roasting whereas the remaining seven perforom all three process steps.

Roasting occurs in multiple-hearth roasters and the newer fluid-bed roasterrs. pg 3.1-15 4 multiple hearth
3 fluid bed

All but one copper plant use reverberatory furnaces (the other uses an electric furnace)

Pierce-Smith converters are the only type converter currently used domestically.

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 12-2-74

Source Primary Copper

K:

Ref 030 pg 6.1-8

during recession of 1971 the copper smelters operated at 82% capacity compared with 90% during the prosperous period of 1970

We assume a utilization factor of .85 within this range and representative of the copper smelting industry during the period 1975 to 1985

$$\therefore K = .85$$

P_c: Ref 030 p 6.1-14

Use assumption of 3% growth rate for copper smelting

$$\therefore$$

$$P_e = .03 \text{ compound}$$

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 12-2-74

Source Primary Copper

P_B: Ref 037 Class 33.2

Asset Guideline period 14 yrs

P_B est → 2×IRS = 28 yrs

$$\frac{100\%\ \text{depreciation}}{28\ \text{yrs}} \cong 3.6\%/\text{yr} \quad \text{simple}$$

$\therefore$

$$\boxed{P_B = .036 \text{ simple}}$$

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 12-2-74

Source Primary Copper

A : Ref 095 pg 233-4531

$$P_{70} = 1{,}765{,}100 \text{ TONS/yr}$$

$$P_{75} = P_{70}(1+P_c)^5 \qquad P_c = .03 \text{ compound}$$

$$P_{75} = 1.7651 \times 10^6 (1.03)^5$$

$$P_{75} \cong 2.05 \times 10^6 \text{ TON/yr}$$

and using $K = .85$ we obtain the production capacity (A) in 1975

$$A = \frac{P_{75}}{K} = \frac{2.05 \times 10^6 \text{ TON/yr}}{.85}$$

$$\therefore \boxed{A = 2.41 \times 10^6 \text{ TON/yr} \quad \text{copper produced primary}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Copper

Particulate

E_u: (Roasting, Smelting, and Converting)

Ref 075 Table 7.3-1

4 units of concentrated ore are required to produce 1 unit weight of copper metal (Note a). Emission factor is stated to be expressed in terms of "units per unit weight of concentrated ore produced".

This at first appears confusing however referring to Ref 049 Table 13-1 pg 262 we obtain emission factors for the above operations in terms of copper produced

Roasting: 168 lb/TON copper
Smelting: 206 lb/TON copper
Converting: 235 lb/TON copper

by using the ratio of 4:1 we convert the data in Ref 075 to lb/TON of copper which agree well with that from 049. except in the case of the smelting furnace

Roasting: 4 × 45 = 180 lb/TON copper
Smelting: 4 × 20 = 80 lb/TON copper
Converting: 4 × 60 = 240 lb/TON copper

The data base for Ref 075 includes Ref 049 and is believed to be more reliable in this instance so that we will use the uncontrolled emission factors presented in it (corrected to copper production basis).

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Computation Sheet For Emission Factors

Calculations Done By W Marrone Date 12-2-74

Source Primary Copper

Particulate cont'd

E_u: With the assumption of about $7/15 = 47\%$ of production being roasted, and that the total emission to be the sum of roasting, smelting, and converting we may calculating

$$E = .47\left(180\ \frac{lb}{TON}\right) + 80\ \frac{lb}{TON} + 240\ \frac{lb}{TON}$$

$$E = 84.6 + 80 + 240$$

$$\therefore\ E \cong 405\ lb/TON \text{ copper produced}$$

$$\boxed{\therefore\ E_u = 405\ lb/TON \text{ copper produced}}$$

E_N: Ref 075 Table 7.3-1 Note c states that 99.7% eff has been reported for reducing particulate emissions

ELECTROSTATIC PRECIPITATORS

$$\therefore\ E_N = .003 \times E_u = .003 \times 405$$

$$E_N \cong 1.22\ lb/TON$$

$$\boxed{\therefore\ E_N = 1.22\ lb/TON \text{ copper produced}}$$

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 12-3-74

Source Primary Copper

Particulate cont'd

E_s: Ref 029 Table 5-1 gives location of copper smelting plants and daily copper production capacities

We assimilate this data to obtain a breakdown of fractional capacity (total) in each state

State	Copper Capacity T/D	Ai
Michigan	220	.046
Montana	500	.106
Nevada	185	.039
N. Mexico	234	.050
Tennessee	50	.011
Texas	260	.055
Utah	750	.159
Washington	300	.063
Arizona	2228	.471
		Σ = 1.000 ✓

Typical Plant Size

4727 T/D Total for industry & 15 plants

$\frac{4727}{15}$ = 315 T/D copper produced

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Copper

Particulate cont'd

E_s:

Referring to Table 5.8 in 029 and using the total scfm along with the copper production (T/D) for plants 1 to 5 which appear typical in that they all have roasting, smelting, and converting we calculate SCFM : T/D ratios:

Plant	SCFM/ T/D
1	1500
2	1323
3	2769
4	2011
5	1523

$$\text{Avg} = 1825 \ \frac{\text{SCFM}}{\text{T/D}}$$

and for a typical plant the discharge rate is $315 \frac{\text{T}}{\text{D}} \times 1825 \frac{\text{SCFM}}{\text{T/D}}$

$$\text{SCFM} = 574{,}875$$

NOTE

Proposed Standards in Ref 029 pg 1.1-1 and 1.1-2 specifies only opacity limits and not particulate emissions.

The process weight rate is assumed ~~input~~ to be $315 \frac{\text{Ton}}{\text{D}} \times 4 \frac{\text{Ton Cr}}{\text{Ton Cu}}$

$$1260 \frac{\text{TON input}}{\text{Day}} \times \frac{\text{day}}{24\,\text{hr}} \times 2000 \frac{\text{lb}}{\text{TON}}$$

$$\text{Process Wt} = 105{,}000 \text{ lb/hr}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Copper

Particulate cont'd

E_s:

based on a process weight rate (input) of 105,000 lb/hr and plant size of 315 T/D copper we determine allowable emission based on state process weight rate curves Ref. 084 & 148

Utah specifies 85% control $E_{si} = 60.8$ lb/TON
Washington specifies no limit $E_{si} = E_u = 405$ lb/TON

Texas	5.07 lb/TON
N. Mexico	3.05 lb/TON
Tenn	2.44 lb/TON
Mich Mont Nev Arizona	3.43 lb/TON

$$E_s = \sum E_{si} \times A_i$$

$$= .159(60.8) + .063(405) + .055(5.07) + .05(3.05) + .011(2.44) + .662(3.43)$$

$$= 9.67 + 25.52 + .28 + .15 + .03 + 2.27$$

$$\boxed{E_s \cong 37.9 \text{ lb/TON copper}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Copper

Sulfur Oxide

E_u: Ref 075 Table 7.3-1

Using the SO_x emissions for roasting, smelting and converting and the 4:1 ratio for concentrate to copper we may calculate an emission factor based on copper produced. (47% of ore roasted does not come into play since all S. is assume to be emitted)

$$E = 4 \times \Sigma E_r + E_s + E_c$$

$$E = 4\,(60 + 320 + 870) = 4 \times 1250 = 5000 \text{ lb/TON copper}$$

$$\boxed{\therefore E_u = 5000 \text{ lb/TON copper}}$$

E_N: Ref 075 Table 7.3-1 Note ⓓ states that sulfuric acid recovery and/or lime-slurry scrubbing may achieve about 90% reduction.

Ref 030 Table 6-12 shows cost data for various control scheme on copper plants. An efficiency of 99.5% is given for electric & flash smelting plant whereas 98.5% is given for roaster/reverb and reverb smelting plants.

We use an efficiency of 99.5% as attainable control tech in 1975

$$E_N = .005 \times E_u = .005 \times 5000$$

$$\boxed{\therefore E_N = 25 \text{ lb/TON copper}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 4-29-75

Source Primary Copper

Sulfur Oxides cont'd

E_3: Ref 084 & 148 limitation of SO_2 emisions from existing state regs. fractional capacity occurrence by state (P_k) is as appears under Particulate E_3 factor calculations.

From Ref 030 pg 6.1-22

Model Smelter 1000 T/D input ore
27% Cu
32% S

We will use this same sulfur conc for determining the sulfur input for a 315 Ton copper /day plant with a 4:1 ore to copper ratio

$$315 \frac{T}{d} \text{ Cu} \times 4 \frac{\text{TON ore}}{\text{TON Cu}} = 1260 \frac{\text{TON}}{d} \text{ ore}$$

$$.32 \times 1260 = 403 \frac{T}{D} \text{ sulfur input}$$

$$403 \frac{T}{D} \times \frac{d}{24 \text{ hr}} \times 2000 \frac{\text{lb}}{\text{TON}} = 33,583 \text{ lb/hr sulfur } \underline{\text{input}}$$

for typical plant

Of the 9 states with copper smelting only Nevada, New Mexico, and Arizona have regulations governing SO_2 emissions from Cu Non-Ferrous smelters. specifically.

Arizona lb SO_2/hr = .1 × lb input S/hr
Nevada " = .2 × "
New Mexico " = .8 × " (exist)
.2 × " (new)

For other states $E_3 = E_4 = 5000$ lb/TON

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 4-29-75

Source Primary Copper

SO_x/ cont'd

E_S: Allowable emissions

	lb SO_x/hr	lb/TON Cu	A_i
Arizona	3358	256	.471
New Mexico	26,866 Ext 6717 New	2047 Ext 512 New	.050
Nevada	6717	512	.039
Remaining 6 states	—	5000	.44

$$E_S(\text{exist}) = .471(256) + .05(2047) + .039(2047) + .44(5000)$$
$$= 120.6 + 102.4 + 79.8 + 2200$$

$$\boxed{E_S(\text{exist}) \cong 2503 \text{ lb/TON copper}}$$

$$E_S(\text{new}) = .471(256) + .05(2047) + .039(512) + .44(5000)$$
$$= 120.6 + 102.4 + 20 + 2200$$

$$\boxed{E_S(\text{new}) = 2443 \text{ lb/TON copper}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-4-74

Source Primary Copper

Summary of Emission Factors

lb/TON copper

Pollutant	E_u	E_N	E_S(existing)	E_S(new)
Particulate	405	1.22	37.9	37.9
SO_x	5000	25	2503	2443

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-23-74

Source Ferroalloy - Electric Submerged Arc Furnace

Ref 239, 240,

Emissions from this industry are generally particulate matter and CO. The level depends highly on the type of alloy, the composition of the alloy, and furnace operation.

We will attempt to evaluate this industry overall by considering the total ferroalloy production and develop emission estimates from "weighted" values of production and reported emission factors.

K:

Ref 239 pg IX-28

Tabulation of parameters for a model furnace is presented on the basis of 90% utilization of full capacity which we assume is representative of this industry

$\boxed{\therefore K = .90}$

2 of 3

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Mansome Date 12-23-74

Source Ferroalloy - Electric Submerged Arc Furnace

A) P_c:

Ref 239 p V-1

identifies the alloy product groups that are associated with the electric submerged arc furnace, which is identified as the largest source of emissions from this industry.

Our study will include the following;

	1971 Production*
Silvery Iron (15-22% FeSi)	94,801
50% Ferrosilicon	377,403
65-90% Ferrosilicon	109,951
Silicon Metal	88,888
Calcium Silicon	10,309
High Carbon - Ferromanganese	266,376
Silicomanganese	150,383
Ferro manganese silicon	44,818
High Carbon - Ferrochrome	113,664
Ferrochrome-silicon	66,685
	1,323,278

*Ref 239 pg VI-14 Table VI-4

$$P_{71} \cong 1.323 \times 10^6 \text{ TONS/yr}$$

From Ref 239 pg II-1 states than for the ten years before 1972 the production grew at an average rate of 1.5 %/yr.

We assume that this overall trend will continue and be applicable to 1971-1985. such that $P_c = .015$ compound

$$P_{75} = P_{71} (1 + .015)^4 = 1.323 \times 10^6 (1.015)^4$$

$$P_{75} \cong 1.40 \times 10^6 \text{ TONS/yr}$$

$\therefore P_c = .015$ compound

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-23-74

Source Ferroalloy

A: cont'd

With $P_{75} = 1.40\times10^6$ TON/yr and a value of K=.90 we may calculate the production capacity in 1975

$$A = \frac{P_{75}}{K} = \frac{1.40\times10^6}{.9} \cong 1.56\times10^6 \text{ TON/yr}$$

$$\therefore A = 1.56\times10^6 \ \frac{\text{TON}}{\text{yr}} \text{ ferro-alloy produced}$$

P_B:

Ref 037 pg 34 Class 33.1

Asset Guideline period = 18 yrs

P_B est ⇒ 2×IRS = 36 yrs

$$\frac{100\%}{36 \text{ yrs}} \cong 2.8\%/\text{yr simple}$$

$$\therefore P_B = .028 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-23-74

Source Ferroalloy - Electric Submerged Arc Furnace

Particulate

E_u: Uncontrolled emission factors are presented in Table VI-4 Ref 239 pg VI-19. These factors are synthesized by "weighting" by the fractional production obtained for 1971

Alloy	A_i 1971 Fractional Production	E lb/TON alloy	$A_i \times E$
Silvery Iron	.072	116	8.352
50% Ferrosilicon	.285	446	127.110
65-90% Ferrosilicon	.083	673	55.859
Silicon Metal	.067	1200	80.400
Calcium Silicon	.008	1343	10.744
HC Ferromanganese	.201	335	67.335
Silicomanganese	.114	219	24.966
Ferromanganese Silicon	.034	315	10.710
HC Ferrochrome	.086	335	28.810
Ferrochrom-Silicon	.050	831	41.550

$\Sigma = 1000$ ✓

$\Sigma \cong 455.8$
$= 456$ lb/TON alloy

$\therefore$

$$\boxed{E_u = 456 \text{ lb/TON ferro alloy produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-23-74

Source Ferroalloy -

Particulate cont'd

E_N: Ref 239 pg II-5 to II-8

Discusses control technology for electric arc furnaces in ferroalloy industry

① 98-99% eff by Wet Scrubber (HE) on open furnace for silicomanganese HC Ferrochromium and ferrochrome-silicon

② 99.9% by HE Venturi Scrubber on covered furnace for ferromanganese silicomanganese and 50% ferrosilicon

③ 75-95% overall for semiclosed furnaces

④ overall controls for closed furnaces are generally better than 99%

⑤ cloth filters on open furnaces achieve 99% for ferrochrome-silicon silicomanganese, silicon metal

We will assume that 99% is achievable in ~~determining~~ determining E_N

$$E_N = .01 \times E_u = .01 \times 456$$

$$\boxed{E_N = 4.56 \text{ lb/TON}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-23-74

Source Ferroalloy

Particulate

E_s Ref 239
pg VIII -5

size range 7,000 -50,000 kw furnaces

since we have no info on size distribution we assume that the typical existing ferroalloy furnace may be represented by the simple average

$$\frac{50+7}{2} = 28.5 \times 10^3 \text{ kw}$$

28.5 megawatts Avg Furnace

R Table
Ref VIII -2 gives $\frac{\text{lb}}{\text{hr}}$ charge/mw which we will "weight" according to alloy production (A_i)
239

Alloy	A_i	(F) lb charge/MW HR	$A_i \times F$
Silvery Iron	.072	1380	99.36
50% Ferrosilicon	.285	1000	285.00
65-90% Ferrosilicon	.083	1020	84.66
Silicon Metal	.067	700	46.90
Calcium Silicon.	.008	660	5.28
HC Ferromanganese	.201	2500	502.50
Silicomanganese	.114	1410	160.74
Ferromanganese silicon	.034	1590	54.06
HC Ferrochrome	.086	1900	163.40
Ferrochrom-Silicon	.050	920	46.00

Total ≅ 1450 $\frac{\text{lb charge}}{\text{MW HR}}$

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Computation Sheet For Emission Factors

Calculations Done By W. Moscone Date 12-23-74

Source Ferroalloy

Particulate cont'd

E_3:

Typical Process Rate = 1450 $\frac{\text{lb charge}}{\text{~~MW~~ HR}}$ × 28.5 ~~MW~~ = 41,325 $\frac{\text{lb}}{\text{hr}}$ input

There are no specific state reg for ferroalloy however we apply Gen Process weight rate curve Ref 084 & 148

Ref 239 Table W-2 gives a distribution of ferroalloy furnaces by state which we assume will be representative for 1975-1988

	No Furn (Ferroalloy)	Ai	E_A Allow Emission lb/hr	Ai × E_A
Ohio	52	.359	31	11.129
Ala	12	.083	23.5	1.951
Penn	0	—	—	
Tenn	14	.097	23.5	2.280
Oregon	8	.055	29	1.595
W.Va	25	.172	29	4.988
N.Y.	6	.041	27.5	1.128
Kent.	11	.076	31	2.356
Iowa	5	.034	31	1.054
Wash	6	.041	###	.041 × E_u'
Tex	3	.021	60.6	1.273
S.C.	2	.014	31.2	.437
N.J.	1	.007	30	.210
TOTAL	195			

$\Sigma = 28.4 + .041 E_u'$ lb/hr

No reported Process Curve assume $E_{S_L} = E_u'$ in (lb/hr)

$$E_3'(\text{lb/hr}) = (28.4 + .041 E_u')\text{lb/hr}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-24-74

Source Ferroalloy

Particulate

E_3:

We must now calculate the typical process output (alloy product) rate. Ref 239 Table VII -2 gives the lb Prod/MW HR which may be combined with the previously calculated value of $A_i \times F$ (lb charge/MW-HR) to determine a "weighted" value for;

lb Product/MW HR

and $\frac{\text{lb Prod}}{\text{MW HR}} \times \text{MW} = \frac{\text{lb Prod}}{\text{hr}}$ (typical)

Alloy	$A_i \times F$	$(A_i \times F) \times \frac{\text{lb prod/MWHR}}{\text{lb charge/MWHR}}$
Silver Iron	99.36	55.44
50% F.S.	285.00	114.00
65-90% FS	84.66	18.84
Silicon Metal	46.90	9.65
Calcium Silicon	5.28	1.36
HC FM	502.50	167.63
SM	160.74	51.76
FMS:	54.06	12.58
HC FC	163.40	40.94
FCS:	46.00	13.50

$\Sigma \cong 485.7 \ \frac{\text{lb prod}}{\text{MW-HR}}$

Typical Prod Rate = $485.7 \frac{\text{lb Prod}}{\text{MW HR}} \times 28.5 \text{ MW} = 13{,}842 \frac{\text{lb}}{\text{hr}}$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-24-74

Source Ferroalloy

Particulate cont'd

E_3:

$$\text{Avg Product Rate} = 13{,}842 \frac{lb}{hr} \cong 6.92 \frac{TON}{hr}$$

$$\text{Uncontrolled Emission Rate} = E_{u} \frac{lb}{TON} \times 6.92 \frac{TON}{hr} = 456 \frac{lb}{TON} \times 6.92 \frac{TON}{hr}$$

$$E'_{ue} = 3155 \text{ lb/hr}$$

Continuing

$$E'_3 \text{ lb/hr} = 28.4 + .041 \, (3155)$$

$$E'_3 \cong 158 \text{ lb/hr}$$

With avg product rate of 6.92 $\frac{TON}{hr}$ we may calculate the value of E_3 in terms of lb/TON.

$$\boxed{E_3 = \frac{158 \frac{lb}{hr}}{6.92 \frac{TON}{hr}} = 22.8 \text{ lb/TON} \text{ ferro alloy product}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-24-74

Source Ferroalloy

CO/ E_u :

Ref 221 pg 29 and pg 30 Table IX

For open furnaces (pg 22 75% of ferroalloy production) the following values are reported

50% FeSi	133 lb/ton prod
75% FeSi	160 "
90% FeSi	182 "
Si Metal	—
Si Mn	—
Fe Mn	101
FeCr	104

We will use the avg from this for E_u estimation

$$E_u = \frac{680}{5} = 136 \text{ lb/TON}$$

$$\therefore E_u = 136 \text{ lb/TON}$$ ferroalloy produced

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Computation Sheet For Emission Factors

Calculations Done By 2J. Marrone Date 12-24-74

Source Ferroalloy

CO/ cont'd

E_N : Ref 239 pg VIII-5 to VIII-8

indicates that co for open furnaces ~~[illegible] [illegible]~~ are often limited by oxidation to CO_2 at the charge surface in the furnace. A large gas volume" results which make control for CO difficult (high vol) Flaring does not appear feasible nor burning for fuel unless the conc is sufficient to support unassitted combustion.

We make the assumption that although unattractive incineration may be employed and 99% eff should be achieved

$$\therefore E_N = .01 \times 136 \cong 1.4 \text{ lb/TON}$$

$$\therefore \boxed{E_N = 1.4 \text{ lb/TON ferroalloy produced}}$$

E_S : Ref 084 & 148

There are no existing state regulations which may be applied to this source. $E_S = E_U$

$$\therefore \boxed{E_S = 136 \text{ lb/TON ferroalloy}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Moorone Date 6-11-75

Source Ferroalloy - Electric Submerged Arc Furnace

Lead/

Ref 277 Vol II appendix B

indicates that the range in lead content for particulate emissions from silicomanganese and ferromanganese furnaces is .05-.1 percent.

We assume the average percent (.075%) to be suitable and justified to apply to ferroalloy industry in general.

The emission factors E_u, E_N, E_s will be determined by applying the .075 % factor to the corresponding values for particulate which assumes that lead control will be the same as for particles.

E_u(lead) = .00075 × 456 lb/TON = .34 lb/TON ferroalloy

E_N(lead) = .00075 × 4.56 lb/TON = .0034 lb/TON ferroalloy

E_s(lead) = .00075 × 22.8 lb/TON = .017 lb/TON ferroalloy

we assume that existing plants may achieve the same degree of control as new plants so that $E_{111d} = E_N$

E_{111d}(lead) = .0034 lb/TON ferroalloy

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-6-75

Source Iron & Steel Industry

This study will include the following subcategories which identify specific operations or production methods within the Integrated Iron and Steel Industry

(1) Blast Furnace (Pig Iron Production)

(2) Basic Oxygen Furnace (BOF)
(3) Open Hearth Furnace (OHF)
(4) Electric Arc Furnace (EAF)

} Steel Production from Pig Iron & Scrap

(5) Sintering
(6) Scarfing

By-Product Coke ovens, which are a part of the Integrated Iron and Steel Industry, have been done separately and appears under the heading "Byproduct Coke Ovens" by W. Marrone.

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-6-75

Source Iron & Steel Industry

K:

Ref 212 pg III-1 and pg IV-1 points out that steelmaking capacity has been difficult for this industry to define and quote. Presently, it is no longer reporting "official" capacity figures.

Ref 234 p 3-59 gives a production in 1968 for BOF at 90% of capacity

Ref 212 Appendix C pg C-66 discusses the lag between production and capacity and actually predicts that production will closely approach capacity. Our approx in 1968 from graph

Prod = 48×10^6
Cap = 52.5×10^6

$$K_{68} = \frac{48}{52.5} = .914$$

In addition, to discussing the difficultly with defining capacity the above ref (212 pg III-1) indicates that this industry may and has often operated at levels above nominal capacity however this can not be expected to occur for long periods.

With lack of definitive info or predictions we must assume a value of K which may be considered representative of the industry. This value of K is to be applied to the whole industry

$$\boxed{\therefore K_{All} = .90}$$

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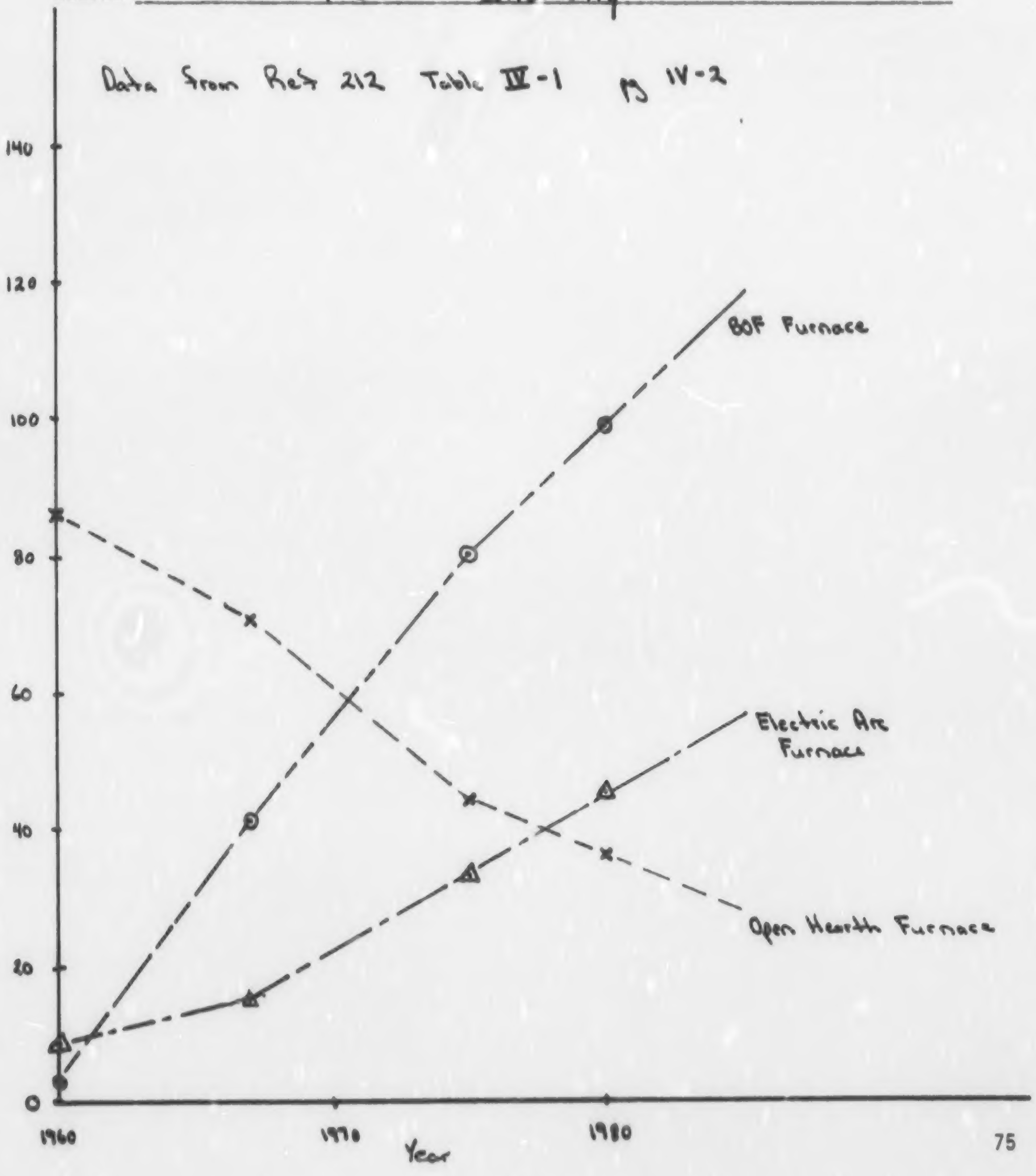
Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-6-75

Source Iron & Steel Industry


Data from Ref 212 Table IV-1 pg IV-2

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-6-75

Source Iron & Steel Industry

A:

Steel Furnaces Production

From the graph on pg 3 of the "Industrial Factors" we may obtain the 1975 Production of Raw Steel by each of the three major steel producing furnaces.

$$\text{BOF } P_{75} = 80 \times 10^6 \text{ TON/yr}$$

$$\text{EAF } P_{75} = 33 \times 10^6 \text{ TON/yr}$$

$$\text{OHF } P_{75} = 44 \times 10^6 \text{ TON/yr}$$

applying $K = .9$ to these value we may estimate the Production capacity (A) in 1975 by; $A = \frac{P_{75}}{K}$

$$\boxed{\begin{aligned} A_{BOF} &= 88.9 \times 10^6 \ \tfrac{\text{TON}}{\text{yr}} \ \text{raw steel produced} \\ A_{EAF} &= 36.7 \times 10^6 \ \tfrac{\text{TON}}{\text{yr}} \ \text{raw steel produced} \\ A_{OHF} &= 48.9 \times 10^6 \ \tfrac{\text{TON}}{\text{yr}} \ \text{raw steel produced} \end{aligned}}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-6-75

Source Iron & Steel Industry

A:

Blast Furnace

Pig Iron Production is developed from Ref 212 Table IV-5 pg IV-6

1995 apparent Pig Iron consumption for raw steel 106.8×10^6 TON with a ratio of .68 TON pig iron / TON raw steel

$$P_{95}(\text{Pig Iron}) = 106.8 \times 10^6 \text{ TON/yr}$$

applying $K = .9$ $\therefore$ $A = \frac{106.8}{.90} \times 10^6 = 118.7 \times 10^6$ TON/yr

this value is checked with Total Steel (Raw) Capacity is see if the value of .68 Pig Iron / Raw Steel holds since all this data comes from the same source.

$$\frac{\text{Pig Iron Cap}}{\text{Raw Steel Cap}} = \frac{118.7 \times 10^6}{(88.9 + 36.7 + 48.9) \times 10^6} = \frac{118.7 \times 10^6}{174.5 \times 10^6} \cong .680 \checkmark$$

$$\boxed{\therefore \; A_{(\text{Blast Furnace})} = 118.7 \times 10^6 \text{ TON/yr pig iron produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-6-75

Source Iron & Steel Industry

A: cont'd

Scarfing : Ref 047 pg 47

In presenting an emission factor it assumes that all steel produced is scarfed [process for removing surface irregularities from semi-finished steel shapes].

Ref 212 pg C-116

presents a plot of % of steel scarfed for the period 1955-1968 with a projection that it will level off at 50%.

We believe this reference to present more definitive data and we make the assumption that scarfing production will be 50% of total steel production

$$A_{scarf} = .5 \times \sum A_{Furnaces}$$

$$A_{scarfing} = .5 \times (88.9 + 36.7 + 48.9) \times 10^{6} \ \frac{TON}{yr} \text{ raw steel scarfed}$$

$$\therefore A \cong 87.3 \times 10^{6} \text{ TON/yr raw steel scarfed}$$

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 1-7-75

Source Iron & Steel Industry

A: cont'd

The most recent production figure for sinter production was for 1967 (Ref 212 Table III-34)

It was shown also in the same reference (Figure C-1) that Sinter was being replaced by pellets in the feed charge of blast furnaces. It is not known how the relative demand for each of these materials stands presently. Our best estimate of sinter production will be developed by assuming that the ratio of sinter produced in 1967 to 1967 pig iron production is valid for 1975-1985. It must be kept in mind however, that the sinter/pellet competition in pig iron production is a major factor in the ultimate production (demand) for these two materials. One interesting factor to also keep in mind is that sintering was basically used to collect fine materials and while not demanded solely by the pig iron production there is a probability that this practice may continue.

		Ref 212
1967 Sinter Production	51,068,111 TONS	Table III-34
1967 Pig Iron Production	86,984,000 TONS	Table III-22

$$\frac{\text{Sinter}}{\text{Pig Iron}} = \frac{51,068,111}{86,984,000} = .587$$

$$A_{\text{sinter}} = .587 \cdot A_{\text{Pig Iron}} = .587 \times 118.7 \times 10^{6}\ \text{TON/yr}$$

$$\boxed{A_{\text{sinter}} = 69.6 \times 10^{6}\ \frac{\text{TON}}{\text{yr}}\ \text{sinter produced}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

P_c:

The growth for each of the steel producing furnaces and the whole steel industry is obtained from the data plotted in the accompaning graph (pg 3 of Industrial Factors)

We assume simple growth during period 1975 - 1985

	Production 10^6 TONS	
	1975	1980
BOF	80.0	99.0
EAF	33.0	45.0
OHF	44.0	36.0
TOTAL	157	180

For simple growth $P_c = \frac{(1980 - 1975)/5}{1975}$

BOF $P_c = \frac{(99 - 80)/5}{80} = .0475$ simple

EAF $P_c = \frac{(45 - 33)/5}{33} = .0727$ simple

OHF $P_c = \frac{(36 - 44)/5}{44} = -.0363$ simple

Total $P_c = \frac{(180 - 157)/5}{157} = .0292$ simple

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 1-7-75

Source Iron and Steel Industry

P_c: cont'd

$\therefore\ P_c\,(\mathrm{BOF}) \cong .048$ simple

$P_c\,(\mathrm{EAF}) \cong .073$ simple

$P_c\,(\mathrm{OHF}) \cong -.036$ simple

Since scarfing is related to total raw steel production then we may represent the growth in scarfing to the simple growth in total raw steel developed above.

$P_c\,(\text{scarfing}) \cong .029$ simple

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

P_c: cont'd

Blast Furnace production was developed (pg 5 "Ind Factors") from a relationship to total raw steel production We may therefore relate the growth in Blast Furnace production to the simple growth in raw steel developed above.

$$\therefore P_c \text{(blast Furnace)} = .029 \text{ simple}$$

From pg 7 of "Industrial Factors" we see that the value of A for sintering was developed directly from a factorization of pig iron production (Blast Furnace) which implies that the growth in sinter production will mirror the blast furnace production growth

$$\therefore P_c \text{(sintering)} = .029 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

P_B : OPEN HEARTH FURNACES

Ref 212 pg V-10 confirms the negative growth rate estimated for this industry and even suggest that by 1990 open hearth furnace production will not exist. We suspect that since BOF and EAF are replacing the Open Hearth Furnace and its growth is negative that P_B for this category is zero

$$\boxed{\therefore P_B(\text{OHF}) = 0.0}$$

All Other Iron & Steel Categories

Ref 037 pg 34 Class 33.1

Asset guideline Period = 18 yrs

P_B est → 2 x IRS = 36 yrs

$$\frac{100\%}{36\text{ yrs}} = 2.\overline{77}\%/\text{yr} \text{ simple}$$

$$\boxed{\therefore P_B\begin{pmatrix}\text{BOF}\\ \text{EAF}\\ \text{Blast Furnace}\\ \text{Sintering}\\ \text{Scarfing}\end{pmatrix} = .028 \text{ simple}}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

Summary of Industrial Factors

Category	K	P_c	P_a	A
Blast Furnace	.90	.029 S	.028 S	$118.7 \times 10^6 \frac{\text{Ton}}{\text{yr}}$ pig iron produced
Basic Oxygen Furnace	.90	.048 S	.028 S	$88.9 \times 10^6 \frac{\text{Ton}}{\text{yr}}$ raw steel produced
Electric Arc Furnace	.90	.073 S	.028 S	$36.7 \times 10^6 \frac{\text{Ton}}{\text{yr}}$ raw steel produced
Open Hearth Furnace	.90	−.036 S	0.0	$48.9 \times 10^6 \frac{\text{Ton}}{\text{yr}}$ raw steel produced
Sintering	.90	.029 S	.028 S	$69.6 \times 10^6 \frac{\text{Ton}}{\text{yr}}$ sinter produced
Scarfing	.90	.029 S	.028 S	$87.3 \times 10^6 \frac{\text{Ton}}{\text{yr}}$ raw steel scarfed

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u :

Blast Furnace

Particulate : Ref 075 Table 7.5-1 E_u = 150 lb/TON pig iron produced assumed

$$\therefore E_u(\text{Pt}) = 150 \text{ lb/TON pig iron produced}$$

Ref 075
Table 7.5-1

CO : $$E_u^{(co)} = 1750 \text{ lb/TON pig iron produced}$$ see next page

As will be discussed under E_u for CO from pg 12 of "Emission Factors" the exhaust stream containing CO is generally used within the plant to recover energy (from heating value) Actual emissions are negligible. Therefore the actual emission (E_u') would be very low. The value above corresponds to no energy recovery.

Trace Metals :

Ref 232 p18 ≈ 1.2% of part emission is magnesium

$$.012 \times 150 \tfrac{\text{lb}}{\text{TON}} = 1.8 \text{ lb } \frac{\text{Mg}}{\text{TON pig iron produced}}$$

Ref 230 Table 6-1 .8 lb Manganese/TON pig iron produced

Ref 230 Table 9-1 .03 lb Vanadium/TON pig iron produced

Total = 1.8 + .8 + .03 = 2.63 lb/TON pig iron

$$\therefore \overset{\text{Trace metals}}{E_u} = 2.63 \text{ lb/TON pig iron produ}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For ~~Industrial~~ Emission Factors (Revised 1-28-75)

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

Blast Furnace

E_u for CO:

The "uncontrolled" emission factor of 1750 lb/TON as obtained above is identified as the emissions from a totally uncontrolled blast furnace operation

Ref 075 pg 7.5-1 and Ref 212 pg C-38 to C-39 indicate that most of the top gas from blast furnaces ~~are~~ is used for heating blast stoves and as a fuel in other operation within the steel plant

Ref 212 pg C-47 also states that the generation of this recyclable fuel in iron smelting is one feature which contributes to the economy of the blast Furnace operation.

Ref 075 pg 7.5-1 Conditions called "slips" can still cause instantaneous emission of CO from a controlled furnace employing energy recovery. This occurrence is becoming minimum due to improved furnace operation and material handling.

We make the judgement that all plants will employ energy recovery so that CO emissions will be negligible during normal production. We feel that emissions during "slips" may still occur sufficiently in existing plants. We assume that emissions from this situation will only be about .1% of the uncontrolled.

$$\boxed{E_u = .001 \times 1750 = 1.75 \text{ lb/TON pig iron produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Basic Oxygen Furnace:

Particulate Ref 075 Table 7.5-1

$$\boxed{E_u = 51 \text{ lb/TON raw steel produced}}$$

CO Ref 075 Table 7.5-1

$$\boxed{E_u = 139 \text{ lb/TON raw steel produced}}$$

Fluoride Ref 075 Table 7.5-1

MW F = 19
MW CaF_2 = 78

occurs as CaF_2 solid

$$E_u' = .2 \frac{\text{lb } CaF_2}{\text{TON raw steel}}$$

in terms of F

$$E_u = .2 \times \frac{19}{78} = .0487 \simeq .049 \text{ lb/TON raw st}$$

$$\boxed{\therefore E_u^{\left(\substack{\text{total}\\\text{Fluoride}}\right)} = .049 \text{ lb/TON raw steel produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Basic Oxygen Furnace

Trace Metals

Ref 230 p6-6 Table 6-1 Manganese 1 lb/TON raw steel

Ref 230 p9-6 Table 9-1 Vanadium .009 lb/TON raw steel

Ref 232 pg 18 Magnesium .5% of emission (Pt) is magnesium

$E' = .005 \times 51 = .255$ lb/TON raw steel

Total = $1 + .009 + .255 \approx 1.26$ lb/TON raw steel

$\therefore E_u = 1.26$ lb/TON raw steel produced

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Electric Arc Furnace

Particulate Ref 047 pg 96 used 10 lb/TON for uncontrolled electric arc furnace

Ref 075 Table 7.5-1

E' for no oxygen lance 9.2 lb/TON
E' for oxygen lance 11.0 lb/TON } avg ≈ 10 lb/TON

Ref 250 pg 9 reports a figure of up to 30 lb/TON for carbon steel and 15 lb/TON for alloy steels from electric arc furnace operations. These emissions are implied to be from total sources; not just the furnace exhaust. Other prominent sources are (1) charging, (2) tapping, (3) oxygen blowing

We believe the latter source of info to be more representative

∴ E_u = 15-30 lb/TON

from Ref 212 pg III-16 Table III-19

Raw Carbon Steel Prod 1967	=	113,190	88.97%
Raw Alloy Steel Prod 1987	=	14,023	11.03%
		127,213	

weighting emission factors by this breakdown we may synthesize a E_u value

$$E = .1103(15) + .8897(30) \cong 1.65 + 26.69 \approx 28.3$$

$$\therefore E_u = 28.3 \text{ lb/TON raw steel produced}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Electric Arc Furnace

Trace Metals

Ref 232 pg 18 Magnesium 5% of emissions (Pt) is magnesium

$.05 \times 28.3 = 1.42$ lb/TON

Ref 230 pg 6-6 Manganese

$$\left.\begin{array}{ll} \text{oxygen lance} & .3 \text{ lb/TON} \\ \text{No lance} & .2 \text{ lb/TON} \end{array}\right\} \text{arith avg} \quad .25 \frac{\text{lb}}{\text{TON}}$$

Total = 1.67 lb/TON raw steel

$$\therefore \boxed{E_u = 1.67 \text{ lb/TON raw steel produced}}$$

CO

Ref 075 Table 7.5-1

$$\boxed{E_u = 18 \text{ lb/TON raw steel produced}}$$

Fluorides

Oxygen-lanced and no-oxygen lanced

gaseous HF .012 lb/TON

solid CaF_2 .238 lb/TON

MW F = 19

MW HF = 20

MW CaF_2 = 78

$$E' = .012 \times \frac{19}{20} = .0114 \text{ lb/TON F as gas}$$

$$E'' = .238 \times \frac{38}{78} = .0580 \text{ lb/TON F as solid}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Electric Arc Furnaces

Fluorides

Total Fluorides as "F" = .0114 + .0580 = .0694 lb/TON

$$\therefore \boxed{E_u \cong .069 \text{ lb/TON raw steel produced}}$$

≈ 83.5% of this is due to solid emission and 16.5% due to gaseous HF emission.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u : cont'd

Open Hearth Furnace

Particulate Ref 047 pg 96 gives a weighted emission factor between oxygen lanced and non-oxygenlanced open hearth production. 17 lb/TON raw steel

based on 8 lb/TON without lancing
21 lb/TON with lancing

and some unspecified % production breakdown & lancing practices.

we determine a breakdown by

$8x + 21y = 17$

and $x + y = 1$

$\therefore y = 1 - x$

$8x + 21 - 21x = 17$

$13x = 3 \quad x = .23$ (23%) without lancing

$\rightarrow y = .77$ (77%) with lancing

$$\boxed{\therefore E_u = 17 \text{ lb/TON raw steel produced}}$$

Trace Metals

Ref 230 pg 6-6

Manganese .1 lb/TON oxygen lance
.6 lb/TON without oxygen lance

weighting these by the above determined lance/no lance ratio.

$E = .23(.6) + .77(.1) \cong .138 + .077$

$E = .215$ lb/TON

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Open Hearth

Trace Metals   Ref 230 pg 9-6   Vanadium .006 lb/ton no oxygen lance
.01 lb/ton oxygen lance

weighting again

$$E = .23(.006) + .73(.01) = .00138 + .0073$$

$$E = .00868 \text{ lb/ton raw steel}$$

Ref 232 pg 18   Magnesium   .3% of Pt emission is magnesium

$$E = .003 \times 17 \tfrac{\text{lb}}{\text{ton}} = .051 \text{ lb/ton raw steel}$$

$$\text{Total trace} = .215 + .0087 + .051 \cong .275 \text{ lb/ton}$$

$$\therefore \boxed{E_u = .275 \text{ lb/ton raw steel produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Open Hearth Furnace

$\boxed{\text{Fluorides}}$

Ref 075 Table 7.5-1

$E' = .1$ lb/TON as HF (gaseous)

$E'' = .03$ lb/TON as CaF_2 (solid)

MW F = 19
MW CaF_2 = 78
MW HF = 20

$E' = .1 \frac{lb}{TON} \times \frac{19}{20} = .095$ lb/TON as F in gaseous form

$E'' = .03 \frac{lb}{TON} \times \frac{19}{78} = .0073$ lb/TON as F in solid

$$\boxed{\text{Total } \overset{E_u}{F} \cong .102 \text{ lb/TON raw steel}}$$

with 7.1% of F from solid
92.9% of F from gas

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Sintering

Particulate Ref 075 Table 7.5-1

E = windbox + discharge = 20 + 22 = 42 lb/TON sinter

$\therefore E_u$ = 42 lb/TON sinter produced

SO_x Ref 075 pg 7.5-5 note ⑨

3 lb SO_2 /TON sinter at windbox

$\therefore E_u$ = 3 lb/TON sinter produced

CO Ref 075 pg 7.5.4

E_u = 44 lb/TON sinter produced

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-7-75

Source Iron and Steel Industry

E_u: cont'd

Scarfing

Particulates Ref 047 pg 97

$$\boxed{E_u = 3 \text{ lb/TON steel scarfed}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 1-8-75

Source Iron and Steel Industry

E_N: Blast Furnaces
Ref 075 pg 7.5-1

discusses control strategy for this source. CO generated and emitted is utilized as fuel within the Steel Mill so that we may expect negligible CO emissions due to this practice. Prior to CO oxidization, the exhaust gases must be cleaned of particulate matter. Ref 212 pg V-8 indicates ≈ 30% to heat stoves 70% to rest of plant for heating

Particulate

Particulate control via primary cyclone or settling chamber
+ wet scrubber
+ venturi or electrostatic precipitator

Table 7.5-1

$$E_N(Pt) = 1.5 \text{ lb/TON pig iron produced}$$

CO

We assume that all the exhaust gas will be utilized in combustion to recover energy or would be flared so that essentially zero CO emissions would result. Emission due to "slips" will also be negligible

$$\therefore E_N(co) = 0.0 \text{ lb/TON pig iron produced}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Blast Furnace

Trace Metals

We make the assumption that trace metals, being particulate matter in the blast furnace exhaust, will be controlled to the same degree as overall particulate removal

$$\text{Eff} = \frac{150 - 1.5}{150} \times 100 = 99\%$$

$$E_N(\text{T.M.}) = .01 \times E_U(\text{T.M.}) = .01 \times 2.63 = .0263 \frac{\text{lb}}{\text{TON}}$$

$$\therefore \boxed{E_N(\text{Trace Metals}) = .026\ \text{lb}/\text{TON} \text{ pig iron produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Basic Oxygen Furnace

CO Ref 075 pg 7.5-3

Carbon monoxide may be reduced to 3 lb/ton or less by combustion in the hood, direct flaring, or other ignition means. We will use, E = 3 lb/ton, to represent E_N

$\therefore E_N^{(co)} = 3$ lb/TON raw steel produced

Particulate

Ref 083 indicates that most if not all BOF are (Ref 075 also) equipped with either venturi scrubber or electrostatic precipitators

Ref 083 pg 563 Design Efficiencies for two sizes.
99.7% & 99.8%

we will use 99.7% in developing E_N

$E_N = .003 \times E_u = .003 \times 51$ lb/ton $\cong .15$ lb/ton

$\therefore E_N^{(pt)} \cong .15$ lb/TON raw steel produced

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd Basic Oxygen Furnace

Trace Metal

We will assume that trace metals will be controlled to the same degree as overall particulate

$$E_N(TM) = .003 \times E_u(TM) = .003 \times 1.26 \frac{lb}{TON} = .00378$$

$$\boxed{\therefore E_N(\text{trace metal}) = .0038\ lb/TON \text{ raw steel produced}}$$

Fluoride

Ref 075 Table 7.5-1

$$E_N' = .002 \frac{lb\ CaF_2}{TON\ steel}$$

MW F = 19
MW CaF_2 = 78

This represents an efficiency of $\frac{.2 - .002}{.2} = 99\%$

We will use however the efficiency of 99.7% which was obtained for particulate

$$E_N(F) = .003 \times E_u(F) = .003 \times .049 \cong .00015 \frac{lb}{TON}$$

$$\boxed{\therefore E_N = .00015\ lb/TON \text{ raw steel produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Electric Arc Furnace

Particulates

Ref 250 pg 44 Table IV-1

achievable control efficiency for Carbon and Alloy steel plants with specified control systems

Carbon Steel	-	DSE & BE Closed roof	98.8%
Alloy Steel		BE & closed roof	94%

weighting these efficiencies by the ratio of carbon & alloy steel determined previously (pg 4 Emission Factors)

≈ 89% Carbon
≈ 11% Alloy

$$\text{Weighted eff} = .89\,(98.8) + .11\,(94)$$
$$= 87.93 + 10.34 = 98.27$$

we will use 98.3% eff $\Rightarrow E_N = .017 \times E_U = .017 \times 28.3 \frac{\text{lb}}{\text{TON}}$

$E_N = .48$ lb/TON

$$\boxed{E_N^{(Pt)} = .48\ \text{lb}/_{\text{TON}}\ \text{raw steel produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Electric Arc Furnace

Trace Metals

attainable efficiency for trace metals is assumed to be the same as for overall particulate

$$E_N(TM) = .017 \times E_u(TM) = .017 \times 1.67 \ \frac{lb}{TON}$$

$$\boxed{\therefore E_N(\text{Trace Metal}) \cong .028 \ lb/TON \ \text{raw steel produced}}$$

CO

Ref 250 Table IV-1 pg 44

attainable CO reduction for Carbon steel 84%
" " " " alloy steel 0%

and by weighting by Carbon/Alloy factors.

$$\text{Weighted eff} = .89(84) + .11(0)$$
$$= 74.76 + 0 \approx 75\%$$

$$E_N^{(co)} = .25 \times E_u^{(co)} = .25 \times 18 \ lb/TON = 4.5 \ lb/TON$$

$$\boxed{\therefore E_N(co) = 4.5 \ lb/TON \ \text{raw steel produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Electric Arc Furnace

Fluorides Ref 075 Table 7.5-1

with venturi scrubber $E'(\text{HF gaseous}) = .0018 \text{ lb}^{\text{HF}}/\text{TON}$

$E'(\text{CaF}_2 \text{ solid}) = .011 \text{ lb CaF}_2/\text{TON}$

MW F = 19
MW HF = 20
MW CaF_2 = 78

$E'(\text{gas}) = .0018 \times \frac{19}{20} = .0017 \text{ lb F}/\text{TON}$

$E'(\text{solid}) = .011 \times \frac{19}{78} = .0027 \text{ lb F}/\text{TON}$

$E'_{\text{TOTAL}}\ .0044 \text{ lb}/\text{TON}$

$\boxed{E_N^{(F)} = .0044 \text{ lb}/\text{TON raw steel produced}}$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 5-8-75

Source Iron and Steel Industry

E_N : cont'd Open Hearth Furnace

Since $P_E < 0$ and $P_B = 0$ we would not expect NSPS to be applied to this industry for criteria pollutants. We will however supply a value for E_N for particulates.

Ref 234 pg 3-83 to 3-87 give mass balance diagrams for typical open hearth controls.

pg 3-86 gives 95% Pt (Total) [illegible]
and 90% Gaseous HF

pg 3-87 gives 95% Pt [illegible]
and 0% Gaseous HF with all HF given converted to solid

it is reasonable to expect 95% control of particulate, total fluoride, and trace metal (treated as the same degree of collection as particulate)

$E_N = .05 \times E_u$

$E_N(Pt) = .05 \times 17 = .85$ lb/TON raw steel

$E_N(TM) = .05 \times .27 = .014$ lb/TON raw steel

$E_N(F) = .05 \times .102 = .005$ lb/TON raw steel

$$\boxed{\left.\begin{array}{l} E_N(Pt) = .85\ \text{lb/TON} \\ E_N(TM) = .014\ \text{lb/TON} \\ E_N(F) = .005\ \text{lb/TON} \end{array}\right\}\text{raw steel}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Sintering

Particulate Ref 075 Table 7.5-1

using cyclone + elec pre on discharge and cyclone + wet scrubb on windbox the emission factor may be reduced to .04 + .11 = .15 lb/TON

$$\therefore \boxed{E_N = .15 \text{ lb/TON sinter produced}}$$

CO & SO_x

Controls for SO_x & CO were not identified in the litterature. It is not likely that these pollutants are presently being controlled from this source. We make the assumption that max impact (hypothetical) would be attained by using $E_N = 0$

$$\therefore \boxed{\begin{aligned} E_N\ (SO_x) &= 0.0 \\ E_N\ (CO) &= 0.0 \end{aligned}}$$

assumed for max hypoth impact

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_N: cont'd

Scarfing

Particulate

Ref 047 pg 222 efficiency stated = 90%

by settling chamber, high energy scrubber, or electrostatic precipitator.

While no other info was obtain we don't see any reason why this type of control system should be able to achieve 99.0%

$E_N = .01 \times 3$ lb/TON

$\therefore$ $E_N = .03$ lb/TON steel scarfed

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

E_{IIId}:

It is assumed that existing plants are able to apply control system so as to achieve the same degree of control as specified by E_{IV} for Trace metals and Fluorides. [all categories]

Blast Furnace: E_{IIId} (Trace Metal) = .026 lb/TON pig iron produced

BOF: E_{IIId} (Trace Metal) = .0038 lb/TON raw steel produced
E_{IIId} (Fluoride) = .00015 lb/TON raw steel produced

EAF: E_{IIId} (Trace metal) = .028 lb/TON raw steel produced
E_{IIId} (Fluoride) = .0044 lb/TON raw steel produced

Open Hearth: E_{IIId} (trace metal) = .014 lb/TON raw steel
E_{IIId} (Fluoride) = .005 lb/TON raw steel

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 1-8-75

Source Iron and Steel Industry

E_s: Ref 148 & 084

SO_x emissions relating to sintering do not exist so that we may assign $E_s = E_u$ for this pollutant.

Sintering $E_s(SO_x) =$ 3 lb/TON sinter produced

Similarly Carbon Monoxide regulation do not exist which may be applied to Iron & Steel plant processes so that $E_s = E_u$

Blast Furnace: $E_s(CO) =$ 1750 lb/TON pig iron produced

BOF : $E_s(CO) =$ 139 lb/TON raw steel produced

EAF : $E_s(CO) =$ 18 lb/TON raw steel produced

Sintering : $E_s(CO) =$ 44 lb/TON sinter produced

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

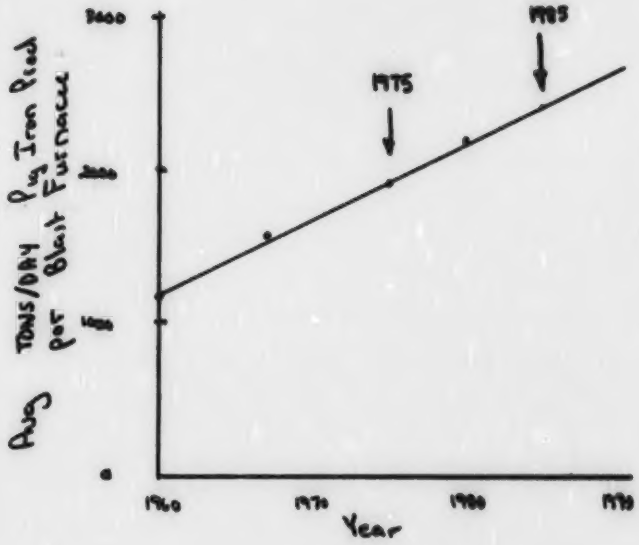
Calculations Done By D. Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd

Particulate

Blast Furnace :



Data: Ref 212
Table IV-8
Pg IV-32

According to reference 212 pg IV-12 the average blast furnace pig iron production is increasing due to the replacement of smaller units with larger units in a way such that the total number of units decreases.

We assume the value of ≈ 2400 $\frac{\text{TON}}{\text{day}}$ (Pig Iron) in 1985 as the representative blast furnace size. and 24 $\frac{\text{hr}}{\text{day}}$ schedule

$$\text{Avg Pig Iron Prod per Furnace} = 2400 \frac{\text{TON}}{\text{day}} \times \frac{\text{day}}{24\ \text{hr}} = 100 \frac{\text{TON}}{\text{hr}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 1-9-75

Source Iron and Steel Industry

E_3: cont'd Particulate

Blast Furnace Ref 075 pg 7.5-1

To produce 1 unit of pig iron required:

(1) 1.55 units iron bearing charge
(2) .55 " coke
(3) .20 " limestone
(4) 2.3 " air

excluding the weight of air the total solids input rate is

$$(1.55 + .55 + .20)/1.0 = 2.3/1.0 = 2.3 \text{ TONS Input}/\text{TON pig iron produced}$$

Therefore for an average furnace with 100 $\frac{\text{TON}}{\text{hr}}$ of Pig iron production implies a process weight rate of $2.3 \times 100 = 230 \frac{\text{TON}}{\text{hr}}$ input

$$\text{PWR} = 230 \frac{\text{TON}}{\text{hr}} \text{ or } 460{,}000 \text{ lb/hr}$$

Ref 236 pg VI-H Avg ACF/TON Pig Iron $= \frac{110+150}{2} = 130{,}000 \frac{\text{ACF}}{\text{TON}}$

using the average stack temp 350 + 540 = 445°F

$$130{,}000 \frac{\text{ACF}}{\text{TON}} \times \frac{70+460}{445+460} = 130{,}000 \times \frac{530}{905} \cong 76{,}100 \frac{\text{SCF}}{\text{TON pig iron}}$$

Use density SCF $= .075 \frac{\text{lb}}{\text{SCF}} \Rightarrow \approx 5700 \frac{\text{lb flue gas}}{\text{TON pig iron}}$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_3: cont'd Particulate

Blast Furnace

From Ref 212 pg III-21 Table III-24

Pig Iron Production by State (1967)

State	Production 10^6 TONS
NY	6.172
Penn	20.542
Maryl, W Va, Kent, Tenn, Tex	10.824
Ala	4.290
Ohio	14.485
Ind	12.167
Ill	6.309
Mich, Minn	7.439
Colo, Utah, Californ.	4.756

For the production data applied to several states we refer to Table III-23 of the above reference and ratio the production for all states by the number of furnaces on blast in the same year.

	No Furn	% of Fur	Production Applied to State	
Maryland	10	55.6	6.02	(From 10.824 × 10^6 Ton)
W Va	4	22.2	2.40	
Kent	2	11.1	1.20	
Tenn	0	0	—	
Tex	2	11.1	1.20	
	18	100% ✓	Σ = 10.82 ✓	
Mich	9	90.0	6.70	(From 7.439 × 10^6 Ton)
Minn	1	10.0	.74	
	10		Σ 7.44 ✓	
Colo	4	36.4	1.73	(From 4.756 × 10^6 Ton)
Utah	3	27.2	1.29	
Calif	4	36.4	1.73	
	11		Σ = 4.75 ✓	

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_s : cont'd Particulate

Blast Furnace

The amended state distribution is as follows: also presented are the allowable state emissions from Ref 148 & 084 and the weighted allowable based on applying the fraction state capacity (A_i)

State	Prod 10^6 TONS	A_i	E Allowable lb/TON Pig Iron	$A_i \times E_{Allow}$
New York	6.17	.071	.63	.0447
Penn	20.54	.236	.52	.1227
Mary	6.02	.069	.60	.0414
W Va	2.40	.028	.45	.0126
Kent	1.20	.014	.60	.0084
Tenn	—	—	—	—
Tex	1.20	.014	1.20	.0168
Ala	4.29	.049	.60	.0294
Ohio	14.49	.167	.60	.1002
Ind	12.17	.140	.60	.0840
Ill	6.31	.073	.45	.0329
Mich	6.70	.077	.58	.0447
Minn	.74	.009	.60	.0054
Colo	1.73	.020	.41	.0082
Utah	1.29	.015	22.50 +	.3375
Calif	1.73	.020	.40 ++	.0080
	Σ 86.98	Σ=1.002 OK roundoff error		Σ = .897

$$E_s = \sum E_{Allow} \times A_i$$

$$E_s = .897 \text{ lb/TON}$$

+ 85% control required

++ Ref 156 pg 37

.9 < 1.5

$E_s < E_N$

which implies that State Reg are more stringent than apparent technology. We assume $E_s = E_N$ as the best that States can do

NOTE

$\therefore E_S \cong$ ~~.90~~ 1.50 lb/TON pig iron produced

see next page

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_S: cont'd Particulate

Blast Furnace:

We see that the value of E_S (.90 lb/TON) is lower than E_N (1.5 lb/TON) which implies that existing State regulations are more stringent than available control technology for this source may attain

The efficiency of 99% which was used to obtain E_N would have to be improved to $\frac{150 - .9}{150} \times 100 = 99.4\%$ Existing control consist of a cyclone, wet scrubber, and electrostatic precipitator in series and unless control designs are improved this source may find it difficult to meet existing state regulations.

We have taken the position that State could not enforce a level lower that present technology and therefore $E_S = E_N$ (for particulate)

$\boxed{E_S = 1.5 \text{ lb/TON pig iron produced}}$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd

Particulate

Sintering: since most sintering is done at the same location and related directly to Blast Furnace operation we assume that the distribution of pig iron production by state will approximate the distribution of sinter. ∴ Use A_i from Blast Furnace

Ref 212 pg V-5 Plant Cap range 2000 - 6000 $\frac{\text{TON}}{\text{day}}$ sinter

Taking the arith avg = 4000 $\frac{\text{TON}}{\text{day}}$ and an using 24 $\frac{\text{hr}}{\text{day}}$

$$PWR = 4000 \frac{\text{TON}}{\text{day}} \times \frac{\text{day}}{24\ \text{hr}} = 167 \frac{\text{TON}}{\text{hr}} \text{ or } 330{,}000 \frac{\text{lb}}{\text{hr}}$$

Ref 236 p VI-13 1.7 - 2.3 scfm / lb/hr exhaust rate for
avg 2.0 scfm/lb/hr sintering entre

therefore the exhaust from a typical
167 $\frac{\text{TON}}{\text{hr}}$ sintering unit is $2 \frac{\text{scfm}}{\text{lb/hr}} \times 330{,}000 \frac{\text{lb}}{\text{hr}} = 660{,}000$ scfm

Allowable emission are obtained from Ref 148 & 084 using the above information

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd

Particulate

Sintering:

Based on Ref. 148 & 084 ↓

State	A_i	E_{si} lb/TON sinter	$A_i \times E_{si}$
New York	.071	.359	.0255
Penn	.236	.677+	.1598
Maryl	.069	.339	.0234
W Va	.028	.245	.0069
Kent	.014	.335	.0047
Tex	.014	.659	.0092
Ala	.049	.335	.0164
Ohio	.167	.335	.0559
Ind	.140	.335	.0469
Ill	.073	.228	.0166
Mich	.077	.335	.0258
Minn	.009	.335	.0030
Colo	.020	.233	.0047
Utah	.015	6.300++	.0945
Calif	.020	.240	.0048

$\Sigma = .4981$

+ using gr/scf limitation
++ using 85% control required

$E_s = \Sigma E_{si} \times A_i$

$$\boxed{\therefore E_s \cong .5 \text{ lb/TON sinter produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd

Particulate

BOF

Ref 044 pg 50 typical BOF furnace size 250 TON

This unit is characterized as producing 470 $\frac{\text{TON}}{\text{hr}}$ raw steel and a average exhaust flow of 375,000 scfm

New Source Standard for BOF from Ref 044 pg 49

.022 gr/scf

$$\frac{375000 \frac{\text{scf}}{\text{min}} \times .022 \frac{\text{gr}}{\text{scf}} \times 60 \frac{\text{min}}{\text{hr}} \times \frac{\text{lb}}{7000\ \text{gr}}}{470 \frac{\text{TON}}{\text{hr}}} = .15\ \text{lb/TON raw steel}$$

Ref 212 pg IV-4 gives the 1980 distribution of raw steel production which we will use for a distribution of BOF production in determining E_s.

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75 .

Source Iron and Steel Industry

E_s: cont'd Particulate

BOF

	Prod 10^6 Tons	
Chicago, Ill	37.8	
Pitt, Pa	31.1	
N.E. Coast	24.5	← (assum mainly Pa Ref 212 Fig III -4)
Youngstown, Pa	12.5	
Detroit, Mich	16.9	
Western	11.7	← (Assume 50% Calif, 15% Utah, 20% Colo, 15% Ariz) Fig III -12
Southern	11.7	← (assume 28% Ala 8% each of Va Fla NC Miss Tenn Tex SC Okla Geo) Fig III -10
Clev., Ohio	10.3	
Buffalo N.Y.	10.3	
Cinn, Ohio	8.9	
St. Lou., Mo	4.3	

Using the above we may redistribute the steel production by state as follows;

State	Prod	A_i
Ala	3.3	.0188
Ill	37.8	.2154
Pa	68.1	.3880
Mich	16.9	.0963
Calif	5.9	.0336
Utah	1.8	.0103
Colo	2.3	.0131
Ariz	1.8	.0103
Va	.9	.0051
NC	.9	.0051
Tenn	.9	.0051
SC	.9	.0051
Geo	.9	.0051
Fla	.9	.0051
Miss	.9	.0051
Tex	.9	.0051
Okla	.9	.0051
Ohio	19.2	.1094
NY	10.3	.0587
	175.5	

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd BOF

assuming that the BOF will be distributed in the same proportions as raw steel production we will develop a value for E_s by weighting each state E_{si} by the value of A_i

E_{si} is obtained from Ref. 148 and 084 using a process weight rate of 470 $\frac{TON}{hr}$ or 940,000 lb/hr – call it 1,000,000 lb/hr

State	Allowable lb/hr	Allow × A_i
Ala	46.8	.880
Ill	69.0	14.863
Pa	47.4	18.391
Mich	69.0	6.645
Calif	40.0	1.344
Utah	3600.0 +	37.080
Colo	46.7	.612
Ariz	69.0	.711
Va	69.0	.352
NC	69.0	.352
Tenn	69.0	.352
SC	69.0	.352
Geo	262.0	1.336
Fla	46.7	.238
Miss	264.0	1.346
Tex	150.0	.765
Okla	69.0	.352
Ohio	69.0	7.549
NY	71.1	4.168

$$E_s' = \Sigma = 97.69 \text{ lb/hr}$$

+ 85% control required

$$E_s = \frac{97.69 \text{ lb/hr}}{470 \text{ TON/hr}} \approx .208 \text{ lb/TON raw steel produced}$$

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 1-9-75

Source Iron and Steel Industry

E_S (cont'd

Particulate

BOF

The value of E_S determined above is representative of existing BOF facilities whereas the NSPS standard developed is for all new facilities

$\therefore$

E_S^{Pt} (Existing) = .208 lb/TON raw steel produced

E_S^{Pt} (New) = .15 lb/TON raw steel produced

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd Particulate

E.A.F

On the following page a graph was developed from data in ref 250 to permit an estimation of the average furnace size.

We estimate 40 TON of Cap as representative of the average existing plant

New plants according to the same ref have been on the order of 300 TON cap

In order to evaluate this industry both for existing and new plants we will use the following info

① Existing Plant 40 TON cap
② New Plant 300 TON Cap
③ Furnace cycle 5 hrs (within range 3.5 - 7 Ref 250 pg 49)
④ 4500 scfm/TON cap exhaust flow (avg value p 49)

$$\text{PWR existing} = \frac{40}{5} = 8\ \frac{\text{TON}}{\text{hr}} \text{ or } 16{,}000\ \text{lb/hr}$$

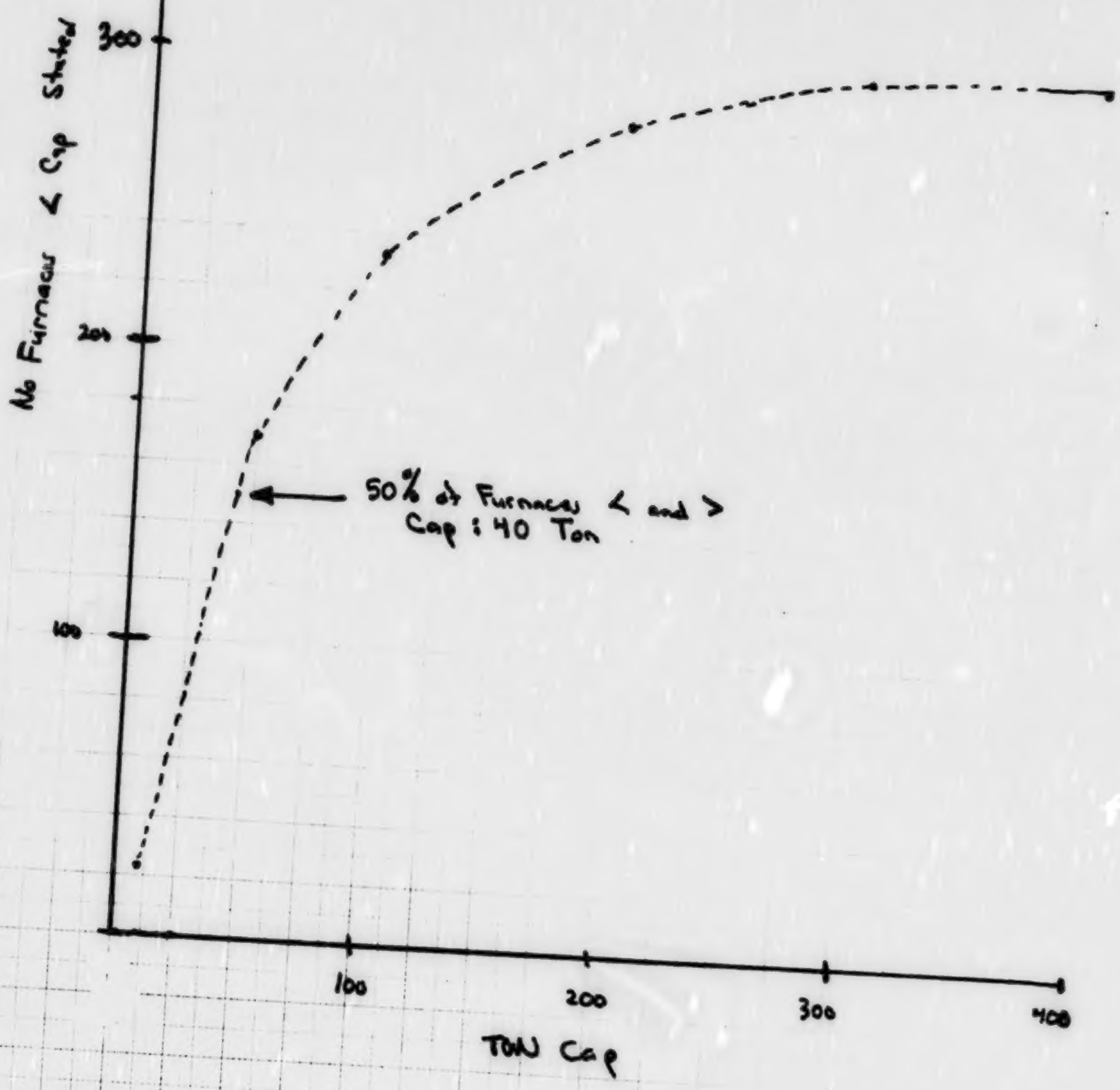
$$\text{PWR new} = \frac{300}{5} = 60\ \frac{\text{TON}}{\text{hr}} \text{ or } 120{,}000\ \text{lb/hr}$$

E_s cont'd

EAF

Iron & Steel

Determination of Avg EAF
Data Ref 250 p.6



50% of Furnaces < and >
Cap : 40 Ton

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-9-75

Source Iron and Steel Industry

E_S: cont'd Particulate

EAF.

Assuming the EAF production to be distributed in the same manner as raw steel production then we may use the A_i value presented on pg 32 of the "Emission Factors"

Exist reg are developed from Ref 148 and 084 using the above information

State	Allow lb/hr	$A_i \times$ Allow
Ala	13.0	.244
Ill	16.5	3.554
Pa	30.8 +	11.950
Mich	162.0	15.601
Calif	13.7 ++	.460
Utah	34.0	.350
Colo	13.0	.170
Ariz	16.5	.170
Va	16.5	.084
NC	16.5	.084
Tenn	13.0	.066
SC	16.5	.084
Geo	16.5	.084
Fla	13.0	.066
Miss	16.5	.084
Tex	24.4	.124
Okla	16.5	.084
Ohio	16.5	1.805
NY	15.0	.881

$\Sigma = 35.95$ lb/hr

\+ using gr/scf regulation

++ Ref 156 pg 77

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 1-9-75

Source Iron and Steel Industry

E_s: cont'd Particulate

EAF

$$E_s' = \frac{35.95 \text{ lb/hr}}{8 \text{ TON/hr}} = 4.49 \text{ lb/TON}$$

We use this factor to be E_s(existing) for EAF

$$E_s(\text{existing}) = 4.49 \text{ lb/TON raw steel produced}$$

For new source of 300 TON cap $60 \frac{\text{TON}}{\text{hr}}$ and
NSPS of .0052 gr/dscf [Ref 250 pg 13]

Using $4500 \frac{\text{scfm}}{\text{TON cap}} \times 300 \text{ TON} = 1{,}350{,}000 \text{ scfm}$

$$\frac{.0052 \frac{\text{gr}}{\cancel{\text{scf}}} \times 1{,}350{,}000 \frac{\cancel{\text{scf}}}{\cancel{\text{min}}} \times 60 \frac{\cancel{\text{min}}}{\text{hr}} \times \frac{\text{lb}}{7000 \text{ gr}}}{60 \frac{\text{TON}}{\text{hr}}} = 1.00 \frac{\text{lb}}{\text{TON}}$$

$$\therefore E_s(\text{new}) = 1.0 \text{ lb/TON raw steel produced}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 5-9-75

Source Iron and Steel Industry

E_5: cont'd Particulate

Open Hearth Furnace.

Ref 212 pg V-10 suggest a range of typical plant size for open hearth furnaces ~~100~~-200 TON/Heat

Ref 234 pg 3-83 describes a typical 200 TON Heat furnace which we will use to develop E_5 assuming it to be close to the average.

200 TON/Heat input

155 TON steel output

Gases N_2 180 TON
O_2 5 TONS
CO_2 75 TONS
260 TONS

$$\frac{260}{155} \times 2000 = 3355 \ \frac{\text{lb gas}}{\text{TON raw steel}}$$

It will be assumed that the distribution (A_i) of raw steel production appearing on pg 12 of "Emission Factors" may be used to represent O.H. Furnace distribution

Ref 084 & 148 only Mich and Pa (of the states with O.H. Furnace prod) have regulations specific to this source

Mich .15 lb/1000 lb gas

Pa .81 lb/TON steel [from allowable $\text{lb/hr} = .76\,(F \times W)^{.42}$]
where F = 20 lb/TON
W = 20 TON/hr input
hr = 10 hrs

$$\frac{\text{lb/hr}}{155} \times \text{hr} = \text{lb/TON steel}$$

All other states will be assumed to control particulate by application of the process weight rate table.

$$\frac{200\ \text{TON}}{10\ \text{hr}} = 20\ \frac{\text{TON}}{\text{hr}} \text{ or } 40{,}000\ \frac{\text{lb}}{\text{hr}} \text{ process weight rate}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 5-9-75

Source Iron and Steel Industry

E_s: cont'd Particulate

Open Hearth Furnace

State	Ai	Allowable lb/TON	Allow × Ai
Ala	.0188	1.45	.0273
Ill	.2154	.84	.1809
Pa	.3880	.81	.3143
Mich	.0963	.50	.0482 +
Calif	.0336	1.83	.0615 ++
Utah	.0103	2.55	.0263 *
Colo	.0131	1.48	.0194
Ariz	.0103	1.93	.0199
Va	.0051	1.93	.0098
NC	.0051	1.93	.0098
Tenn	.0051	1.48	.0075
SC	.0051	1.93	.0098
Geo	.0051	1.93	.0098
Fla	.0051	1.45	.0074
Miss	.0051	1.93	.0098
Tex	.0051	3.87	.0197
Okla	.0051	1.93	.0098
Ohio	.1094	1.93	.2111
NY	.0587	1.74	.1021

$\Sigma =$ 1.1044 lb/TON steel

+ based on allowable .15 lb/1000 lb gas, and 3355 lb gas/TON steel

* based on 85% control required

++ use allowable table for LAAPCD ref 156 pg 37

$$\therefore \boxed{E_s = 1.1 \text{ lb/TON raw steel}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s: cont'd Particulate Scarfing

Information regarding a representative size scarfing operation could not be obtained from the literature nor was there sufficient information to directly determine the size.

We will make a rough estimate by making the following assumptions.

(1) BOF avg size 470 TON/HR pg 31 "Emission Factors"
(2) EAF " " 8 TON/HR pg 35 "Emission Factors"
(3) OHF " " 15 TON/HR p V-10 Ref 212
1975 (4) $\frac{88.9}{174.5} \cong .51$ or 51% of cap by BOF
(5) $\frac{36.7}{174.5} \approx .21$ or 21% of cap by EAF
(6) $\frac{48.9}{174.5} \approx .28$ or 28% of cap by OHF

weighting the representative sizes by the capacities we may obtain an estimate of "typical" furnace size

$$\text{Avg Size} = (.51 \times 470) + (.21 \times 8) + (.28 \times 15)$$
$$= 239.7 + 1.68 + 4.2$$

$$\text{Avg Size} = 245 \text{ TON/HR}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s: cont'd Particulate

Scarfing

Using 245 TON/HR and assuming that an average plant will have 3 such furnaces and also that 50% (see pg 6 "Industrial Factors") of raw steel produced is scarfed.

$$.5 \times (3 \times 245) \cong 368 \frac{\text{TON}}{\text{HR}}$$ for scarfing operation

$$PWR = 368 \frac{\text{TON}}{\text{HR}} \text{ or } 736{,}000 \text{ lb/HR}$$

Scarfing will be assumed to occur in the same states as previously identified for steel production and distributed according to the values of A_i (pg 32 "Emission Factors") used in developing E_s factors for the BOF & EAF.

Allowable State emission for this process weight rate will be obtained from Ref 148 & 084 by applying the Particulate Process Weight Rate Tables. State allowable levels will be weighted by A_i to determine an overall E_s

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s: cont'd Particulate $\boxed{\text{Scarfing}}$

State	Allowable lb/hr	Ai × Allow
Ala	65.0	1.222
Ill	57.0	12.278
Pa	32.0	12.416
Mich	65.0	6.260
Calif	40.0	1.344
Utah	166.0+	1.710
Colo	44.5	.583
Ariz	65.0	.670
Va	65.0	.332
NC	65.0	.332
Tenn	46.0	.235
SC	65.0	.332
Geo	210.0	1.071
Fla	45.5	.232
Miss	210.0	1.071
Tex	137.0	.699
Okla	65.0	.332
Ohio	65.0	7.111
NY	68.0	3.992
		Σ = 50.9 lb/hr

+ 15% control required

$$E'_s = 50.9 \text{ lb/hr}$$

$$E_s = \frac{50.9 \text{ lb/hr}}{368 \text{ TON/hr}} = .138 \text{ lb/TON}$$

$\therefore E_s = .138$ lb/TON steel scarfed.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 5-9-75

Source Iron and Steel Industry

E_S cont'd Ref 148 & 084

Fluoride emission regulations do not exist for Iron & Steel plants and strictly speaking the value of E_S would be assumed equal to E_4. The fluoride emissions occur from the steelmaking furnaces. [BOF, EAF, OHF]

Both gaseous and solid fluoride compounds are emitted

For BOF all solid CaF_2 emission 100% of F in solid
For EAF 83.5% of F in solid form
16.5% of F in gaseous form

by default particulate emission regulations will be, in effect stipulating a fluoride regulation; at least for the solid portion of the total fluoride emission. The gaseous fluoride is assumed to be permitted uncontrolled.

Ref 234 pg 3-81 & 3-83 all F emitted from OH. Furnace is in gaseous HF form

$$\therefore E_{S(F)} = E_4 = .102 \text{ lb/ton steel}$$

Open Hearth Furnace

$$\boxed{E_S(F) = .102 \text{ lb/TON raw steel}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s: cont'd

Fluoride BOF

From pg 2 "Emission Factors"

$$E_u(F) = .049 \text{ lb/TON}$$

$$E_u(Pt) = 51 \text{ lb/TON}$$

Fluoride allowable E_s will be determined by ratioing the $E_u(F)$ to $E_u(Pt)$ and applying this to $E_s(Pt)$ to obtain $E_s(F)$

$$\boxed{\begin{aligned} E_s(F)(\text{exist}) &= \frac{.049}{51} \times E_s^{Pt}(\text{exist}) = \frac{.049}{51} \times .208 \cong .0002 \text{ lb/TON} \\ E_s(F)\text{ New} &= \frac{.049}{51} \times E_s(Pt)\text{ New} = \frac{.049}{51} \times .15 \cong .00015 \text{ lb/TON} \end{aligned}}$$

assumed = to E_u
instead of .000144

EAF

$E_u(F) = .069$
$E_u(Pt) = 28.3$

83.5% is solid and will be applied under E_s
16.5% is gas and is consider uncontrollable

$$\therefore E_s = .165(.069) + \frac{.069}{28.3}(.835)\left[E_{s\,\text{exist}}^{Pt}\right]$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s cont'd

Fluoride

$\boxed{\text{EAF}}$

$$E_s(F)\ \text{new} = .165(.069) + \frac{.069(.835)}{28.3}[1.0]$$

$$E_s(F) \cong .0114 + .0020$$

$$\boxed{E_s(F)\ \text{new} \cong .0134\ \text{lb/TON raw steel produced.}}$$

$$E_s(F)_{\text{exist}} = .165(.069) + \frac{.069(.835)}{28.3}[4.49]$$

$$\cong .0114 + .0091$$

$$\boxed{E_s(F)\ \text{exist} \cong .021\ \text{lb/TON raw steel produced}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By 2J. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s: cont'd

Trace Metals

Trace metals will be treated similarly as fluoride since particulate reg will be default limit the allowable trace metal emissions

Blast Furnace

$$E_s \text{(Trace Met)} = \frac{E_u \text{(TM)}}{E_u \text{(PT)}} \times E_s \text{(PT)}$$

$$E_s \text{(TM)} = \frac{2.63}{150} \times .90 \cong .016 \text{ lb/TON pig iron produced}$$

This value E_s is less than E_N and may be discussed similarly as was the $E_s < E_N$ for particulate "Emission Factor" pg 28

$$E_s \text{(Trace Metal)} = .\cancel{01}6 \text{ lb/TON pig iron produced}$$

Note $E_s < E_N$ and as discussed on pg 27 & 28 of Emission Factor we set $E_s = E_N$

$$E_s \text{(TM)} = .026 \text{ lb/TON pig "}$$

BOF

$$E_s \text{(TM) exist} = \frac{E_u \text{(TM)}}{E_u \text{(PT)}} \times E_s \text{(PT) exist}$$

$$E_s \text{(TM) exist} = \frac{1.26}{51} \times .208 = .0051 \text{ lb/TON raw steel produced}$$

$$E_s \text{(TM) New} = \frac{1.26}{51} \times E_s \text{(PT) New}$$

$$E_s \text{(TM)}_{\text{New}} = \frac{1.26}{51} \times .15 = .0037 \text{ lb/TON}$$

This is assumed equivalent to E_N since it differs only slightly

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-10-75

Source Iron and Steel Industry

E_s cont'd

Trace Metals

BOF

$$E_{s\,(\text{Trac met})\,\text{New}} = .0038 \text{ lb/TON raw steel produced}$$

EAF

$$E_s(\text{TM})\text{ exit} = \frac{E_u(\text{TM})}{E_u(\text{PT})} \times E_s(\text{PT})\text{ exit}$$

$$E_s(\text{TM})_{\text{exit}} = \frac{1.67}{28.3} \times 4.49 \cong .265 \text{ lb/TON raw steel produced}$$

$$E_s(\text{TM})\text{ new} = \frac{1.67}{28.3} \times E_s(\text{PT})\text{ new}$$

$$E_s(\text{TM})_{\text{new}} = \frac{1.67}{28.3} \times 1.00 \cong .059 \text{ lb/TON raw steel produced}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 5-9-75

Source Iron & Steel Industry

E_s cont'd

Trace Metals

$\boxed{\text{OHF}}$

$$E_s(\text{TM}) = \frac{E_u(\text{TM})}{E_u(\text{Pt})} \times E_s(\text{Pt}) = \frac{.275}{17} \times 1.1 \cong .018 \ \frac{\text{lb}}{\text{TON}}$$

$$E_s(\text{TM}) = .018 \ \text{lb/TON raw steel}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-8-75

Source Iron and Steel Industry

Summary of Emission Factors

Category	Units	Pollutant	E_u	E_N	E_{MM}	E_s	Comments
Blast Furnace	lb/TON pig iron produced	Pt	150	1.5	—	1.5	
		CO	1.750	0.0	—	1.750	
		TR. met	2.63	.026	.026	.026	
Basic Oxygen Furnace	lb/TON raw steel produced	Pt	51	.15	—	.208 Exist .15 New	
		CO	139	3	—	139	
		TR. met	1.26	.0038	.0038	.0051 Exist .0038 New	
		F	.049	.00015	.00015	.0002 Exist .00015 New	
Electric Arc Furnace	lb/TON raw steel produced	Pt	28.3	.48	—	4.49 Exist 1.00 New	
		CO	18	4.5	—	18	
		Tr. Met	1.67	.028	.028	.265 Exist .059 New	
		F	.069	.0044	.0044	.021 Exist .0134 New	
Open Hearth Furnace	lb/TON raw steel produced	Pt	17	.85	—	1.1	Neg Pc TB=0
		TR	.275	.014	.014	.018	
		F	.102	.005	.005	.102	
Sintering	lb/TON sinter produced	Pt	42	.15	—	.50	
		SO_2	3.0	0.0 *	—	3.0	
		CO	44	0.0 *	—	44	
Scarfing	lb/TON steel scarfed	Pt	3.0	.03	—	.138	

* set equal to zero for max hypothetical emission NSPS impact evaluation

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Lead

P_c: Ref 030 pg 6.3-5

"The overall growth rate in lead consumption for the United States is estimated at 2-3% per year between 1971 and 1975. It is doubtful that this rate will change appreciably after 1975."

This statement clearly indicated a growth in lead consumption ie production however,

pg 6.3-5 also states

"It is doubtful that any new smelters will be constructed in the United States in the near future since the industry as a whole is currently under utilized with regard to pig lead production capacity and the domestic consumption of lead appears to be relatively stable. Whereas, it is true that some pig lead is imported, it is doubtful that domestic lead industry would add additional capacity in order to try to capture the market share that is currently going to foreign markets."

We interpret this to mean that production capacity will not be growing, yet production will which is equivalent to saying that growth will be taken up by a increasing value of K.

With this in mind we assume the following:

① A in 1975 = A 1985

② $P_c = 0$

③ K increasing from 1975 to 1985

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Lead

P_c :

Since capacity growth in the near future appears nil and we assume this covers the period 1975-1985 we have;

$$\boxed{P_c = 0}$$

A : Ref 030 Table 6-23 pg 6.3-2

Capacity 1971 = 765,000 TONS/yr

Assuming no new capacity between 1971 and 1975 then

Capacity 1975 = 765,000 TON/yr Lead produced

$\therefore$

$$\boxed{A = .765 \times 10^6 \text{ TON/yr Lead produced}}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Lead

K: Ref 030 pg 6.3-1

Capacity utilization in 1971 was 85% for the industry as a whole (four producers) however, two of the four producers were operating at 99% utilization of capacity.

We make the assumption that the existing value of K (1975) is .85 and that by the year 1985 the value will increase to .99.

Note

This is a loose assumption especially since new capacity may at any time be developed, which would realize a growth in capacity $(P_c > 0)$ and a decrease in K. to some level significantly less than .99.

$$\therefore \boxed{\begin{array}{l} K_{\substack{\text{existing}\\1975}} = .85 \\ K_{\substack{\text{New}\\1985}} = .99 \end{array}}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Lead

P_B :

Ref 037 Section Class 33.2

Asset guideline period 14 yrs

P_B est → 2×IRS = 28 yrs

$\frac{\text{100\% depreciation}}{\text{28 yrs}} \cong 3.6\%/\text{yr}$ simple

$$\therefore \boxed{P_B = .036 \text{ simple}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By 21 Masrone Date 12-3-74

Source Primary Lead

Particulate

E_u : Ref 049 Table 13-1 Particulate emissions from

① Sintering 520 lb/TON Lead
② Blast Furnace 250 lb/TON Lead
③ Dross Reverb Furnace 20 lb/TON Lead

$$E_u = \Sigma E = 520 + 250 + 20 = 790 \text{ lb/TON lead}$$

$$\boxed{\therefore E_u = 790 \text{ lb/TON Lead}}$$

E_N : Ref 075 Table 7.6-1 Note ⓑ gives collection efficiency for
electrostatic precipitator 96%
baghouse system 99+%

Ref 029 Table 5.4 Plant # 6 uses a baghouse- spray system on the sintering, blast furnace & reverb furnace with 99.8% for sinter and 99.9% for blast & reverb as collection efficiency.

We assume a collection efficiency of 99.85% as attainable for lead smelters.

$$E_N = .0015 \times E_u = .0015 \times 790 \cong 1.19 \text{ lb/TON lead}$$

$$\boxed{E_N = 1.19 \text{ lb/TON Lead}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Lead

Particulates cont'd

E_S :

Ref 029 Table 5-4 pg 5.3-3

Provides a distribution of capacity of lead smelting by state from which fractional capacity occurring in each state may be determined

State	Capacity T/day Lead	A_i
Idaho	350	.199
Montana	105	.060
Missouri	1152	.656
Texas	150	.085
		Σ = 1.000 ✓

6 plants & 1757 Total T/D Lead

Average Plant size = 293 T/D Lead

A rough estimate of SCFM / $\frac{T/D}{\text{Lead}}$ is obtained from the data in the Table (5.4) with the exclusion of Plant 4 since part of its scfm is dilution and ventilation air;

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-4-74

Source Primary Lead

Particulate cont'd

E_s :

Plant	SCFM/T/D
①	990
②	690
④	647
⑤	1602
⑥	3066

Avg = 1399

For a 293 T/D lead smelting plant

$$\text{SCFM} = 293\ \text{T/D} \times 1399\ \frac{\text{SCFM}}{\text{T/D}} = 409{,}907\ \text{SCFM}$$

A proposed limit of .022 gr/scf (Ref 029 pg 1.1-2) is used to calculate a value for E_S(new) particulate.

$$E = \frac{.022\ \frac{\text{gr}}{\text{scf}} \times 409{,}907\ \frac{\text{scf}}{\text{min}} \times 60\ \frac{\text{min}}{\text{hr}} \times \frac{\text{lb}}{7000\ \text{gr}} \times 24\ \frac{\text{hr}}{\text{day}}}{293\ \text{T/day}} = 6.33\ \text{lb/TON Lead}$$

3.06 lb/TON Lead

$$\boxed{E_S(\text{new}) = \cancel{6.33}\ \text{lb/TON Lead}}$$

Note since E_S(existing) < E_S(new) the E_S(new) = E_S(existing)

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-4-74

Source Primary Lead

Particulate cont'd

E_S :

For existing plants the emission limit will be determined by applying the generalized process weight rate table for the four states having lead smelting capacity

Ref 075 Table 7.6-1 2 Ton ore → 1 TON lead

$$\text{Average Process Weight Rate} = 293 \frac{\text{Ton lead}}{\text{day}} \times \frac{\text{day}}{24\,\text{hr}} \times 2 \frac{\text{Ton ore}}{1\,\text{T lead}} \times 2000 \frac{\text{lb}}{\text{TON}}$$

$$= 48{,}833\ \text{lb/hr input}$$

Ref 084 & 148

State	E_{Si} lb/TON Lead	$A_i \times E_{Si}$
Idaho	2.87	.57
Montana	2.87	.17
Missouri	2.87	1.88
Texas	5.12	.44

$$E_S(\text{existing}) = \sum E_{Si} \times A_i = 3.06\ \text{lb/TON lead}$$

$$\therefore E_S(\text{existing}) = 3.06\ \text{lb/TON Lead}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Maxone Date 4-29-75

Source Primary Lead

SO_x / E_u: Ref 075 Table 7.6-1 and Note ⑧ and ⑨

$$E = 660 \text{ lb/TON of ore conc}$$

2 TON ore → 1 TON metal lead

$$\therefore E_u = 660 \frac{\text{lb}}{\text{TON ore}} \times \frac{2 \text{ TON ore}}{1 \text{ TON lead}} = 1320 \text{ lb/TON lead}$$

$$\boxed{\therefore E_u = 1320 \text{ lb/TON lead}}$$

E_N: Ref 030 pg 7.5-17

best level of control achievable (98.5%) based on
(1) utilization of recirculating sinter machine
(2) scrubbing (DMA?) to weak SO_2 stream of blast furnace
(3) DA acid plant to strong stream of sinter machine

$$E_N = .015 \times E_u = .015 \times 1320 = 19.8 \text{ lb/TON lead}$$

$$\boxed{\therefore E_N = 19.8 \text{ lb/TON lead}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 4-29-75

Source Primary Lead

SO_x/ cont'd

Ref 148 & 084

E_s: None of the four states have existing regulation pertaining to SO_x emissions from non-ferrous smelters specifically.

In this case $E_s = E_u = 1320$ lb/TON lead

$$\boxed{\therefore E_s = 1320 \ \text{lb}^{SO_2}/\text{TON lead}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Lead

Lead

E_u: Ref 136 "Primary Lead Smelters"

$$\boxed{E_u = 37 \text{ lb/TON Lead}}$$

This is a second-hand value based on data from one test which we hope would be confirmed when more data is available.

E_N:

We will assume that the collection efficiency of lead will be identical as for the total particulate emission (99.85%)

$$\therefore E_N = .0015 \times E_u = .0015 \times 37 \text{ lb/TON Lead}$$

$$\boxed{\therefore E_N = .056 \text{ lb/TON lead}}$$

E_{IIId}: It is assumed that the fabric filters may be retrofitted on existing plants to achieve the same efficiency as for new plants

$$\therefore E_{IIId} = E_N = .056 \text{ lb/TON lead}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-75

Source Primary Lead

Lead/ cont'd

E_S:

Ref 148 & 084

Specific regulation for lead do not exist however we assume the lead may be controlled "defacto" u/c the particulate PWR table

$$\boxed{E_{S_{\text{Lead}}} \quad \frac{\overset{\downarrow E_u}{37 \text{ lb Pb}}}{790 \text{ lb Pt}} \times \overset{E_s(Pt)}{\downarrow} 3.06 = .14 \text{ lb/TON}_{\text{Lead}}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-4-74

Source Primary Lead

Summary of Emission Factors

lb/TON Lead

Pollutant	E_u	E_N	E_{111d}	E_S(existing)	E_S(new)
Particulate	790	1.19	/	3.06	3.06
SO_x	1320	19.8	/	1320	1320
Lead	37	.056	.056	.14	.14

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 12-2-74

Source Primary Zinc

P_c: Ref 030 pg 6.2-4

growth rate of 3.5%/yr cited for domestic consumption which we assume will coincide with growth in zinc capacity

$$\therefore P_C = .035 \text{ compound}$$

P_B: Ref 037 Class 33.2

Asset guideline period 14 yrs

P_B est → 2×IRS = 28 yrs

$$\frac{100\% \text{ depreciation}}{28 \text{ yrs}} \cong 3.6\%/\text{yr simple}$$

$$\therefore P_B = .036 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Zinc

K:

Ref 095 pg 233.6833 under Note(3)

Capacity Primary Zinc Slab 1969 was 1,225,700 TONS/yr

Production Primary Zinc Slab 1969 was 1,020,900 TON/yr

$$K = \frac{1.0209}{1.2257} = .83$$

We assume this value representative of primary zinc refineries

$$\boxed{K = .83}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-2-74

Source Primary Zinc

A:

Ref 030 pg 6.2-5

1975 total domestic demand = 1,450,000 TON/yr

Slab zinc- imports = 25% of Total

If we assume consumption = production then we calculate domestic production in 1975 as;

$$P_{75} = 1.45 \times 10^6 \frac{\text{TON}}{\text{yr}} \times .75 \cong 1.088 \times 10^6 \text{ TON/yr}$$

and employing $K = .83$ → $A = \frac{P_{75}}{K} = \frac{1.088 \times 10^6}{.83}$

$$\therefore A = 1.31 \times 10^6 \text{ TON/yr zinc produced}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Zinc

Particulates

E_u: This factor will be developed by combining emissions from roasting, sintering, and distillation

Ref 049 Table 13-1 pg 262

90% of production is roasted with 75% in Fluid-bed-suspension roasters
15% in Multiple-hearth

60% of production is sintered

60% of production is distilled

Emission factors as presented in the Table will be weighted according to fraction of production for each operation

$$E = .75\left(2000\,\frac{lb}{ton\ zinc}\right) + .15\left(333\,\frac{lb}{ton\ zinc}\right) + .10(0) + .6(180) + .6(12) + .4(0) + .4(0)$$

$$E = 1500 + 49.95 + 0 + 108 + 7.2 + 0 + 0$$

$$E \cong 1665 \text{ lb/TON zinc produced}$$

$$\boxed{\therefore E_u = 1665 \text{ lb/TON zinc produced}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Zinc

Particulate cont'd.

E_N: Ref 075 p7.7-1 cites the use of electrostatic precipitators and baghouse as acceptable devices for controlling zinc smelting plants

We assume that an efficiency of 99.85% (comperable to lead smelter) is applicable to zinc smelter

$$E_N = .0015 \times E_u = .0015 \times 1665 \cong 2.50 \text{ lb/TON zinc}$$

Note we see that the calculate value of E_s (new) on pg.— is less the E_N

E_s (new) = 2.25 lb/TON
E_N calc. = 2.50

This would at first, imply that the NSPS proposed are stringent for this industry in requiring a controll efficiency of about 99.9% ∴ However, Ref 030 p 7.5-21 and 7.5-26 indicates that the applicablity of a baghouse system to zinc smelter should achieve 99.9% or better efficiency

We therefore assume $E_N = .001 \times E_u \cong 1.67$ lb/TON

∴ $\boxed{E_N = 1.67 \text{ lb/TON}}$

It is important to see that the existing and proposed regulations are closely controlling this industry.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Zinc

Particulates cont'd.

E_s: Ref 029 Table 5-3 gives the location and zinc smelting production (T/D) by state for the seven zinc producing smelters.

State	Zinc capacity T/D	A_i
Texas	435	.207
Oklahoma	415	.197
Idaho	300	.143
Pa.	955	.453
		Σ=1.000 ✓

Typical Plant Size

2105 T/D Total for industry & 7 plants

$$\frac{2105}{7} \cong 300 \text{ T/D zinc produced}$$

From the same table we calculate the SCFM/T/D zinc for the representative plants ④, ⑥, ⑦, ⑫

④ - 325 SCFM/T/D
⑥ - 764 SCFM/T/D
⑦ - 422 SCFM/T/D
⑫ - 480 SCFM/T/D

} Avg ≈ 498 SCFM/T/D zinc

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Zinc

Particulates cont'd

E_s: For a 300 $\frac{T}{D}$ zinc plant :

$$SCFM = 300\ T/D \times 498\ \frac{SCFM}{T/D} = 149{,}400\ SCFM$$

E_s (NEW)

A proposed limit (Ref 029 p1.1-2) of .022 $\frac{\text{grain}}{\text{scf}}$ is used to calculate E_s (New) particulate.

$$E = \frac{\frac{.022\ gr}{SCF} \times 149{,}400\ \frac{scf}{min.} \times 60\ \frac{min}{hr} \times \frac{lb}{7000\ gr} \times \frac{24\ hr}{day}}{300\ \frac{\text{Ton Zinc}}{day}}$$

$$\boxed{E_s(\text{new}) = 2.25\ lb/\text{TON zinc}}$$

E_s (existing)

For existing plants the emission limit will be set by using the process weight rate curve for the effected states.

Ref 075 Table 7.7-1

$$\text{Process}\ \overset{\text{Average}}{\text{Weight}}\ \text{Rate} = 300\ \frac{\text{Ton Zinc}}{\text{Day}} \times \frac{\text{Day}}{24\ hr} \times 2\ \frac{\text{TON ore}}{\text{TON zinc}} \times \frac{2000\ lb}{\text{TON}}$$

$$= 50{,}000\ lb/hr\ \text{input}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-3-74

Source Primary Zinc

Particulate cont'd.

E_s:

Ref 084 & 148

	E_{si} lb/ton zinc	$A_i \times E_{si}$
Texas	5.04	1.04
Okla.	2.84	.56
Idaho	2.84	.41
Penn.	4.09	1.85

$$E_s(\text{existing}) = \Sigma E_{si} \times A_i$$
$$= 3.86 \text{ lb/ton zinc}$$

$$\boxed{\therefore E_s(\text{existing}) = 3.86 \text{ lb/ton zinc}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 4-29-75

Source Primary Zinc

SO_x/E_u: Ref. 075 Table 7.7-1 Note ②

$E = 1100$ lb/TON ore and $2 \frac{\text{TON ore}}{\text{TON zinc}}$

$E = 1100 \frac{\text{lb}}{\text{TON ore}} \times 2 \frac{\text{TON ore}}{\text{TON zinc}}$

$E = 2200$ lb SO_2/TON zinc produced

$$\boxed{\therefore E_u = 2200 \text{ lb } SO_2\text{/TON zinc}}$$

E_N: Ref 030 pg 7.5-13 to 7.5-15

We assume application of DA acid plant to roaster and similar control to sinter machine obtaining a control efficiency of 98.5%.

$E_N = .015 \times E_u = .015 \times 2200 = 33$ lb/TON zinc

$$\boxed{\therefore E_N = 33 \text{ lb/TON zinc}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 4-29-75

Source Primary Zinc

SO_x/ cont'd.

Ref 084 & 148

E_s: Of the 4 states with zinc smelting capacity only Oklahoma has specific regs. for SO_2 emissions (new plants only) $(A_i = .197)$

For other states $(A_i = 1.0 - .197 = .803)$ $E_{S_i} = E_u = 2200 \frac{lb}{TON}$

Ref 030 p6.2-25
30% Sulfur in zinc ore

For a 300 T/D zinc production plant

$$.3 \times 300 \frac{\text{TON zinc}}{\text{day}} \times \frac{2 \text{ TON ore}}{\text{TON zinc}} = 180 \frac{\text{TONS S}}{\text{day}}$$

$$180 \frac{\text{TONS}}{\text{day}} S \times \frac{d}{24 \text{ hr}} \times 2000 \frac{lb}{\text{TON}} = 15{,}000 \frac{lb}{hr} S \text{ input}$$

$$E'_{s\,(\text{new only})} \quad lb/hr\ SO_2 = .564\,(lb/hr\ S)^{.85}$$

$$= .564\,(15{,}000)^{.85} \cong 2000\ /hr\ SO_2$$

$$E''_s(\text{new}) = \frac{2000\ lb/hr}{300\ \text{TON}/\text{day} \times \frac{\text{day}}{24\ hr}} = 160\ lb/\text{TON}$$

$$E_s(\text{new}) = .197(160) + .803(2200)$$
$$= 31.5 + 1766.6 \cong 1798\ lb/\text{TON}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 4-29-75

Source Primary Zinc

SO_x/ cont'd.

E_s:

since there are no exist reg. $E_s(\text{exist}) = E_u = 2200$ lb/TON and $E_s(\text{new}) = 1798$ lb/TON

$$\boxed{\begin{array}{l} E_s(\text{exist}) = 2200 \text{ lb/TON zinc} \\ E_s(\text{new}) = 1798 \text{ lb/TON zinc} \end{array}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 12-4-74

Source Primary Zinc

Summary of Emission Factors

lb/TON zinc

Pollutant	E_u	E_M	E_s (exist)	E_s (new)	
Particulate	1665	1.67	3.86	2.25	
SO_x	2200	33	2200	1798	

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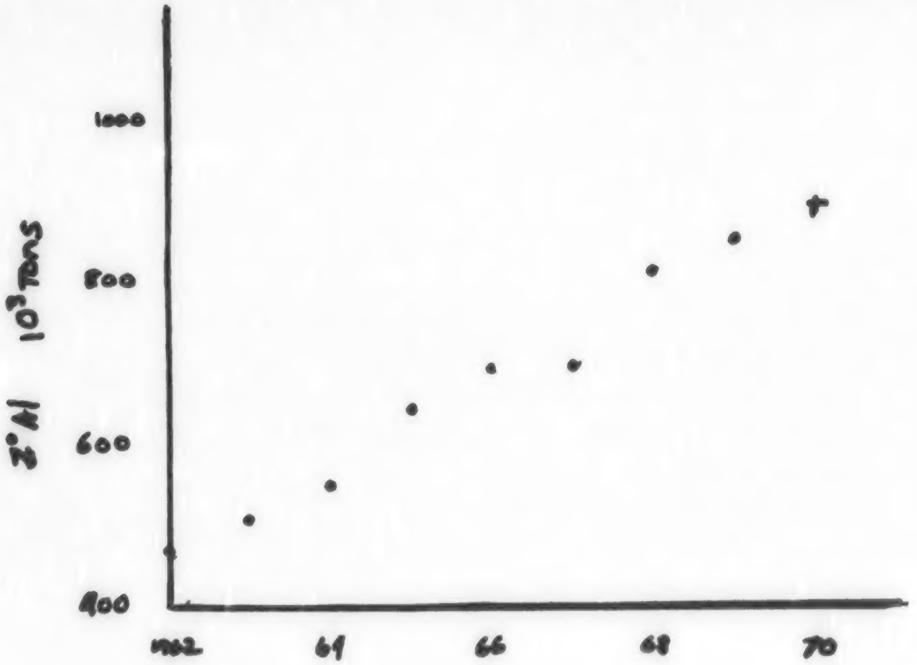
Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/8/75

Source Secondary Aluminum

Ref (95) gives 2° Al. production data from 1930 - 1969
The 1969 value is 856.2×10^3 Tons



Ref (132) p 1 gives the 1970 production of $(781{,}000) \times (1.15) = 898.2 \times 10^3$
This is compatible with Ref. (95)

The avg. (simple) growth between 1962 & 1970 is

$$\frac{898.2 \times 10^3 - 461.8 \times 10^3}{8} = 54.55 \times 10^3 \ \frac{\text{TONS}}{\text{YR.}}$$

1975 Production $= 898.2 \times 10^3 + 5(54.55 \times 10^3) = 1.171 \times 10^6$ Tons

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Calculations Done By Hopper Date 1/8/75

Source 2° Al

$$P_c = \frac{54.55\times10^3}{1.171\times10^6} = 4.66\%$$

$$\boxed{P_c = 0.0466}$$ simple ← Assume applicable to sweating & reverb. furnaces

Of the total 2° Al produced, about 81% of the mat'l comes from new scrap; the remaining 19% comes from old scrap. (Ref ⑬② p1

We will assume that 50% of all old scrap and 10% of all new scrap is processed through sweat furnaces. This is based on the following points:

(1) Old scrap is relatively "dirty" and can be mixtures of other elements

(2) New scrap is relatively clean as it consists of turnings, borings, clippings etc.

$$A_{\substack{\text{sweat}\\ \text{furn.}}} = \left[(.10)(.81)(1.171\times10^6) + (.50)(.19)(1.171\times10^6)\right] \div K$$
$$= \left[9.485\times10^4 + 1.112\times10^5\right] = K\left(2.061\times10^5\right)\div K$$

2° Al sweat furnaces & 2° Pb sweat furnaces are similar in nature & in many cases are interchangeable (Ref ⑤ p113 ff)
We will, ∴ use a K = to that for 2° Pb (See "Industrial Factors Secondary Lead")

$$\boxed{K_{\text{sweat furnace}} = 0.68}$$

$$A_{\text{sweat}} = \frac{2.061\times10^5}{.68} = 0.303\times10^6 \ \frac{\text{tons}}{\text{Al}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/9/75

Source 2° Aluminum

$$\boxed{A_{\text{SWEAT FURNACE}} = 0.303 \times 10^6 \text{ Tons Al}}$$

We will assume that all 2° Al has been processed through a reverbatory furnace.

No information could be found for K specifically for this operation. We will use the capacity utilization value for "Advanced process non-ferrous metals". The avg K for 1965-1975 is 82%

REF (144) P 48-TAB 1 & P50 TAB 2

$$\boxed{K_{\text{REVERB FURN.}} = 0.82}$$

$$A_{\text{reverb}} = 1.171 \times 10^6 / 0.82 = 1.428 \times 10^6$$

$$\boxed{A_{\text{REVERB FURN.}} = 1.428 \times 10^6 \text{ Tons Al}}$$

We will assume the absolescence rate to be equal for both furnace types and this will be a function of twice the IRS depreciation allowance for the mfg. of non ferrous metals. Ref (37) p 34

$$P_B = \frac{1}{(2)(14 \text{ yrs})} = 0.036$$

$$\boxed{P_B = 0.036}$$ simple

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By [illegible] Date 1/2/75

Source Secondary Aluminum

SWEAT FURNACES

FROM Ref (89) p 116

$$\boxed{E_{Up \atop \text{SWEAT}} = 33\ \text{LB}/\tfrac{\text{TON}}{\text{AL}}}$$

A/B's followed by a baghouse is recommended as the control equip't (Ref [illegible] p 438) Ref [illegible] TAB 19-12 p 439 indicates an $\eta = 94.1\%$ using such a system

$$E_{N_p} = (1 - .94)(33) = 1.98$$

$$\boxed{E_{N_p \atop \text{SWEAT}} = 1.98\ \text{LB}/\tfrac{\text{TON}}{\text{AL}}}$$

Ref (89) p 116 indicates the avg. capacity of a sweat furnace is 1000 LB/HR of Al. For a feed/product ratio of

$$\frac{1.0}{0.6} = 1.67 \quad \text{(Same page, same Ref)}$$

the typical PWR = 1670 LB/HR = 0.835 TPH

Ref (132) p 1 states that in 1970, there were 75 Aluminum smelters in the U.S. Since we do not have the specific geographical distribution of capacity, we will use the generalized PWR curve.

For a PWR = 1670 pph, the allowable rate is 3.68 LB/HR

$$E_{Sp \atop \text{SWEAT}} = \frac{3.68\ \text{LB}/\text{HR}}{1000\ \frac{\text{LB Al}}{\text{HR}}} \times 2000\ \frac{\text{LB}}{\text{TON}} = 7.36\ \text{LB}/\tfrac{\text{TON}}{\text{Al}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/9/75

Source 2° Alum.

$$\boxed{E_{\underset{\text{SWEAT}}{sp}} = 7.36 \ \text{LB}/\tfrac{\text{TON}}{\text{Alum.}}}$$

Reverbatory Furnaces - Particulates

Ref (214) p 3-115,116 states that particulate emissions from reverb furnaces are 2-4 LB/TON (Assume 3) during the smelting operation & 600 LB per TON Cl_2 during demagging.

Ref (132) TAB 1 STATES

300 LB/HR of PART. per 600 LB/HR of Cl_2 for a 75,000# capacity furnace

$$\frac{300(2000)}{600} = 1000 \ \text{LB}/\text{Ton } Cl_2$$ This value is in agreement.

On a LB/ton Al basis:

Ref (132) p 5 states that the avg batch cycle time is ~ 24 hrs. for a unit rated @ 75,000# Al

$$\frac{75{,}000}{(24)(2000)} = 1.563 \ \frac{\text{Tons Al}}{\text{HR}}$$

$$E_{U_P} = 3.0 + \frac{300}{1.563} = 195 \ \text{LB}/\text{ton}$$

$$\boxed{E_{\underset{\text{Reverb}}{UP}} = 195 \ \text{LB}/\tfrac{\text{ton}}{\text{Alum.}}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/10/75

Source 2° Aluminum

Ref (132) TAB 4 The use of a wet (fluid bed) scrubber can reduce emissions of particulate to 1.5 LB/HR

$$E_{N_P} = \frac{1.5}{1.563} = 0.96$$

$\boxed{\eta = 99.59\%}$

$$\boxed{E_{N_P\,\text{REVERB}} = 0.96\ \text{LB}/\text{TON ALUM.}}$$

To det'n Es, the following assumptions are made

75,000 LB/MELT of Al (Ref (132) TAB 4)

$$\text{FEED/PRODUCT} = \frac{1\#\ \text{SCRAP}}{0.9\#\text{Al}}$$

wt flux = (0.333)(wt scrap) Ref (119) p 7.8.45, 46

24 hrs/batch Ref (132) p5

$$\frac{(75{,}000)(1.333)}{(24)(0.90)} = 4630\ \text{LB/HR}$$

Again, we will use the gen'l PWR curve since the geographical distribution of capacity is not known.

Allow = 7.5 LB/HR
for 1.563 TPH of Al

$$E_{S_P\,\text{REVERB}} = 7.5/1.563 = 4.80\ \text{LB/ton}$$

$$\boxed{E_{S_P\,\text{REVERB}} = 4.80\ \text{LB/ton Al}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/10/75

Source 2° Aluminum.

Ref (132) TAB 3 states that Cl_2 emissions range between 0.1 & 0.3 LB Cl_2/LB Cl_2 feed

Assuming the avg = 0.2

$$\frac{0.2\ \frac{\text{LB}\ Cl_2}{\text{LB}\ Cl_2\ \text{feed}} \times 600\ \frac{\text{LB}\ Cl_2\ \text{feed}}{\text{hr}}}{1.563\ \frac{\text{Tons Al}}{\text{hr}}} = 76.8\ \text{LB}/\text{ton Al}$$

$$\boxed{EU_{\underset{\text{Revised}}{Cl_2}} = 76.8\ \text{LB}/\text{ton Alum.}}$$

Ref (132) TAB 4 indicates that a wet scrubber will reduce chlorine emissions to "trace". We will ∴ assume 99.9%

$$E_N = (1 - .999)(76.8) = 0.077$$

$$\boxed{E_{N_{\underset{\text{Revised}}{Cl_2}}} = 0.077\ \text{LB}/\text{ton Al}}$$

We will assume that a wet scrubber can be retrofit to existing installations as a gen'l rule. ∴ $E_{111d} = E_N$

$$\boxed{E_{\underset{\text{Revised}}{\underset{Cl_2}{111(d)}}} = 0.077\ \text{LB}/\text{ton Al}}$$

Since there are no regs. for Cl_2, $E_S = EU$.

$$\boxed{ES_{\underset{\text{Revised}}{Cl_2}} = 76.8\ \text{LB}/\text{ton Alum.}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/10/75

Source 2° Aluminum

ACID MIST (HCl)

Ref (132) TAB 4 STATES hydrogen chloride emissions of 237 LB/HR for a 75,000 LB furnace (1.563 TPH Al)

$$EU_{HCl} = \frac{237}{1.563} = 151.6$$

$$\boxed{EU_{\substack{HCl\\REVERB}} = 151.6 \ \mathrm{LB/}\tfrac{\mathrm{Ton}}{\mathrm{Al}}}$$

Same Ref + TAB

The wet scrubber can reduce the HCl emission to "trace"

We will assume an $\eta = 99.9\%$

$$E_{N\,HCl} = 151.6\,(1-.999) = 0.152 \ \mathrm{LB/}\tfrac{\mathrm{Ton}}{\mathrm{Al}}$$

$$\boxed{E_{\substack{N\,HCl\\REVERB}} = 0.152 \ \mathrm{LB/}\tfrac{\mathrm{Ton}}{\mathrm{AL}}}$$

As was the case with Cl_2

$$\boxed{E_{\substack{111(d)\\HCl\\REVERB}} = 0.152 \ \mathrm{LB/}\tfrac{\mathrm{Ton}}{\mathrm{AL}}}$$

Since there are no regs for acid mist, $E_S = E_U$

$$\boxed{ES_{\substack{HCl\\REVERB}} = 151.6 \ \mathrm{LB/}\tfrac{\mathrm{Ton}}{\mathrm{Al}}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/13/75

Source 2° Aluminum

Sweat Furnace

	E_U	E_N	E_S
Part.	33	1.98	7.36

Reverb Furnace

	E_U	E_N	E_S	E_{111d}
Pt	195	.96	4.80	—
Cl_2	76.8	.077	76.8	.077
Acid Mist	151.6	.152	151.6	.152

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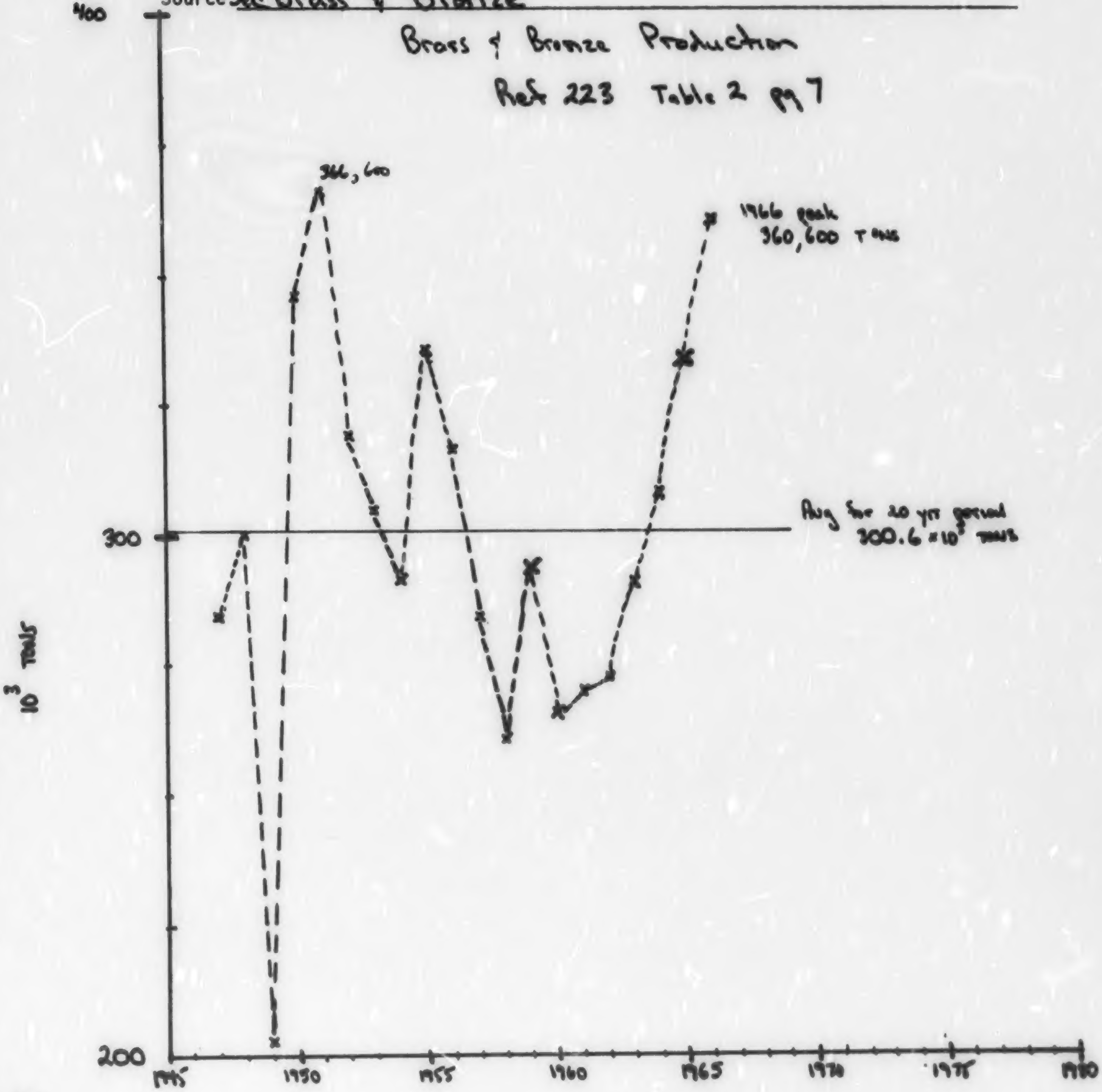
Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-26-74

Source See Brass & Bronze



Brass & Bronze Production

Ref 223 Table 2 pg 7

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Calculations Done By W. Marrone Date 12-26-74

Source Sec Brass & Bronze

P_c:

The preceding plot of brass and bronze production indicates a fluctuating production history for this industry during the period 1947-1966

Ref 044 pg 48 confirms that 1965-1966 was a peak and that production has declined since then. It goes on to stay the excess capacity exists within the industry and few, if any, new plants are expected to be constructed in the next few years.

We make the assumption that existing capacity will be sufficient to meet brass & bronze demands. and the new capacity will not be constructed during 1975-1985

$$\boxed{\therefore P_c = 0}$$

K: Information for the determination of K was not ~~not~~ found in the literature. Since it has been mentioned that overcapacity exists we make a best estimate by comparing the average production rate of $\approx 300 \times 10^3$ TON/yr with some likily maximum

est Peak = 375,000 TON/yr
Avg = 300,000 TON/yr

$K = \frac{300,000}{375,000} = .8$

$$\therefore \boxed{K = .80}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Massone Date 12-26-74

Source See Brass & Bronze

A : Since we have assumed $P_c = 0$ and used on average production and estimate peak for determination of K then the value of A (1975 production capacity) is represented by the peak production level of 375,000 TON/yr used above:

$$\therefore A = .375 \times 10^6 \text{ TON/yr}$$

P_B : Ref 037 pg 34 Class 33.2

Asset Guideline period = 14 yrs
P_B est → 2×IRS = 28 yrs

$\frac{100\%}{28 \text{ yrs}} \cong 3.6\,\%/\text{yr}$ simple

$$\therefore P_B = .036 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-26-74

Source See Brass & Bronze

Particulates Ref 223 pg 1-2

Emission from this industry are mainly attributable to refining furnaces (reverb, rotary, electric, crucible [blast])

Ref 044 pg 45 states

(1) 95% of production is from reverb furnaces which has highest emission level

(2) with the exception of blast (crucible) furnace, which has emission compreable to reverb, all other furnaces have lower emissions levels

E_u:

Ref 075 Table 7.9-1

$$E = 70 \text{ lb/TON metal charged}$$

Ref 223 pg 2

avg emission factor for reverb furnace = 60-80 lb/TON ingot

We will use 70 lb/TON metal produced

$$\therefore \boxed{E_u = 70 \text{ lb/TON metal produced}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-28-74

Source Sec Brass & Bronze

Particulate cont'd

E_N:

Ref 075 pg 7.9-2

The use of a baghouse, which is the predominant control device used in this industry, may achieve collection efficiencies of 95-99.6%

We will use a value of 99.6% as attainable in developing E_N

$$E_N = .004 \times E_u = .004 \times 70 \text{ lb/TON}$$

$$\therefore \boxed{E_N = .28 \text{ lb/TON}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-26-74

Source Sec Brass & Bronze

Particulate

E_s:

New Source Performance standards have been proposed for this industry so that a value of E_s (new) will be determined.

Ref 044 pg 46 states that the proposed standard will require emissions to be limited to 1.0 - 1.5 lb/hr from a 25 T/D furnace
Typical

Note
Ref 271 pg 9312 states that the promulgated standard is the same as the proposed

assuming $24\frac{hr}{d}$

$$\frac{1.0\frac{lb}{hr}}{25\frac{T}{D} \div 24\frac{hr}{D}} = .96 \text{ lb/TON}$$

$$\frac{1.5\frac{lb}{hr}}{25\frac{T}{D} \div 24\frac{hr}{D}} = 1.44 \text{ lb/TON}$$

> avg 1.2 lb/TON

Based on the avg this represents ≈ 98% eff.

$$\boxed{E_s\,(\text{new}) = 1.2 \text{ lb/TON}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-26-74

Source See Brass & Bronze

Particulate cont'd

Ref 044 pg 45-46 discusses regulation in terms of a typical 25 TON/day furnace

assuming a production schedule of 24 hr/day we obtain $\frac{25 \times 2000}{24\ \text{hr}} = 2083\ \text{lb/hr} \approx 2000\ \frac{\text{lb}}{\text{hr}}$ or $1\ \frac{\text{TON}}{\text{hr}}$ as a process input weight rate.

A breakdown of sec brass & bronze production by state was not obtained however by referring to Ref 223 & 124 we we able to see that several states were identified as major contributors to brass and bronze production.

We develop an E_s (existing) factor by making the following assumptions:

(1) the states identified are New York, Penn, Ohio, Alabama, Illinois, Kansas, Virginia, Delaware.

(2) allowable emission for each state based on process weight of 2000 lb/hr will be given equal weighting so that $E_s\ \text{avg} = \frac{\Sigma E_s}{N}$ where $N = 8$.

(3) allowable emissions for any other state not covered will be considered to be equal to this avg

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 12-26-74

Source See Brass & Bronze

State	lb/hr Allowable Emissions
NY	3.65
Penn	2.25*
Ohio	4.10
Alabama	3.60
Illinois	4.10
Kansas	4.10
Virginia	4.10
Delaware	1.20*

Avg ≅ 3.39 lb/hr

* based on gr/scf regulation compared to regulation in Ref. 044 for new source

.022 gr/scf is proposed
or 1.2 lb/hr

$$E_S = \frac{3.39\ \text{lb/hr}}{2083\ \frac{\text{lb}}{\text{hr}} \times \frac{\text{TON metal}}{2000\ \text{lb}}} = 3.25\ \text{lb/TON metal produced}$$

$$\boxed{E_S^{PT}(\text{existing}) = 3.25\ \text{lb/TON metal produced}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-26-74

Source Sec Brass & Bronze

Lead and Zinc

Ref 044 p45 identifies most of the particulate emissions to be lead oxides and zinc oxides

45 to 77% Zn Oxides
1 to 13% Pb Oxides
in emissions

We will use the average of these percentages in determining the emission factors. ∴ $E_u Pb = .065 \times E_u pt$
$E_u Zn = .61 \times E_u pt$

It is assumed that (1) control devices will be equally effective on these constituents as for total particulate so that

$$E_{N Pb} = .004 \times E_{u\,Pb}$$

$$E_{N Zn} = .004 \times E_{u\,Zn}$$

(2) Since controls that are instituted for particulate source are controlling Pb & Zn simultaneously we must assume that the Allowable emissions are a function of the E_s for particulate and proportional to the Zn and Pb content

$$E_s(\text{new})\,Pb = .065 \times E_s(\text{new})$$

$$E_s(\text{new})\,Zn = .61 \times E_s(\text{new})$$

$$E_s(\text{existing})\,Pb = .065 \times E_s(\text{existing})$$

$$E_s(\text{existing})\,Zn = .61 \times E_s(\text{existing})$$

(3) Existing plants are assumed to be able to apply baghouses to reverb furnaces and achieve same control efficiency as new plant ∴ $E_{111d} = E_N\,(Pb \text{ or } Zn)$

Project Number - 32391 New Source Performance Standards

Computation Sheet for Emission Factors

Calculations Done By W. Marrone Date 12-26-74

Source Sec Brass & Bronze

Lead & Zinc Cont'd

E_u :

$E_u\, Pb = .065 \times 70 \cong 4.6$ lb/TON

$E_u\, Zn = .61 \times 70 = 42.7$ lb/TON

$\therefore$ $E_u(Pb) = 4.6$ lb/TON metal produced

$E_u(Zn) = 42.7$ lb/TON metal produced

E_N :

$E_N = .004 \times E_u$

$E_{IIId} = E_N$

$E_N(Pb) = .004 \times 4.6$ lb/TON $= .018$

$E_N(Zn) = .004 \times 42.7$ lb/TON $= .17$

$\therefore$ $E_{IIId} = E_N(Pb) = .018$ lb/TON metal produced

$E_{IIId} = E_N(Zn) = .17$ lb/TON metal produced

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Computation Sheet For Emission Factors

Calculations Done By W. Marron Date 12-26-74

Source Sec Brass & Bronze

Lead and Zinc cont'd

E_s (new) Pb = .065 × 1.2 lb/TON = .078 lb/TON metal prod

E_s (new) Zn = .61 × 1.2 lb/TON = .73 lb/TON meta prod

E_s (existing) Pb = .065 × 3.25 lb/TON = .21 lb/TON metal produced

E_s (existing) Zn = .61 × 3.25 lb/TON = 1.98 lb/TON metal produced

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-28-75

Source Core Ovens - Iron Foundry

K:

We will use the value of K = .93 obtained for Cast Iron Foundry as representative of core ovens

$$\boxed{K = .93}$$

P_c : The growth in core production is assumed a direct effect of cast iron growth. From "Cast Iron Foundry" by W. Marrone - plot of Cast Iron production and total production gives a growth rate (simple) of ;

$$P_c = \frac{\frac{25.2 - 21.4}{5}}{21.4} = .035 \text{ simple}$$

$$\boxed{P_c = .035 \text{ simple}}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-28-75

Source Core Oven - Iron Foundry

A :

A will be assumed equivalent to the sum of cupola and electric cast iron production capacity.

$$\begin{aligned} A_{cupola} &= 14.9 \times 10^6 \\ A_{elec} &= \underline{8.1 \times 10^6} \\ & 23.0 \times 10^6 \text{ TON/yr} \end{aligned}$$

$$\therefore \boxed{A = 23 \times 10^6 \ \frac{\text{TON}}{\text{yr}} \text{ metal casted}}$$

P_B :

Use P_B obtained for electric furnace in Cast Iron which was derived from IRS Tables Ref 037

$$\boxed{P_B = .028 \text{ simple}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-28-75

Source Core Ovens - Iron Foundry

Hydrocarbons

E_u: Ref 047 pg 175 gives figures for 1968 of 18,000,000 TON metal cast and 10,500,000 TON of sand used. This gives us a fraction of;

$$\frac{10.5 \times 10^6}{18 \times 10^6} = .583 \ \frac{\text{TON sand}}{\text{TON iron cast}}$$

From Ref 046 p 313 for typical core mixture of;

930 lb sand
7.5 lb core oil { 45% linseed oil, 28% gum rosin, 27% Kerosene }
9.0 lb cereal binder
3.0 lb Kerosene
38 lb water

HC Emissions are assumed to be 45% + 27 % of core oil and 3 lb kerosene or .72(7.5 lb) + 3.0 = 5.4 + 3.0 = 8.4 lb HC

$$\frac{8.4 \text{ lb HC}}{930 \text{ lb sand}} \times \frac{2000 \text{ lb}}{\text{TON}} \cong 18 \ \text{lb}^{\text{HC}}/\text{TON sand}$$

Then

$$\boxed{E_u = .583 \ \frac{\text{TON sand}}{\text{TON iron cast}} \times 18 \ \frac{\text{lb HC}}{\text{TON sand}} \cong 10.5 \ \frac{\text{lb}}{\text{TON iron cast}}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-28-75

Source Core Ovens - Iron Foundry

Hydrocarbons cont'd

E_N:

Emission reduction from core ovens may be achieved through modification of core oil mixture however this may not always be feasible.

Ref 046 pg 314 - 315 indicates that afterburners are generally applied to this source for control of organic material.

Without any definitive test data to define an efficiency we will assume that at least 90% can be achieved for this source $E_N = .10 \times E_u$

$$\boxed{E_N = 1.05 \text{ lb/TON} \ \substack{\text{iron} \\ \text{cast}}}$$

E_S:

State Regulations for hydrocarbons (Ref 084 & 148) are not applicable to core ovens so that we may state that $E_S = E_u$

$$\boxed{\therefore E_S = 10.5 \text{ lb/TON} \ \substack{\text{iron} \\ \text{cast}}}$$

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Project Number - 32391 New Source Performance Standards

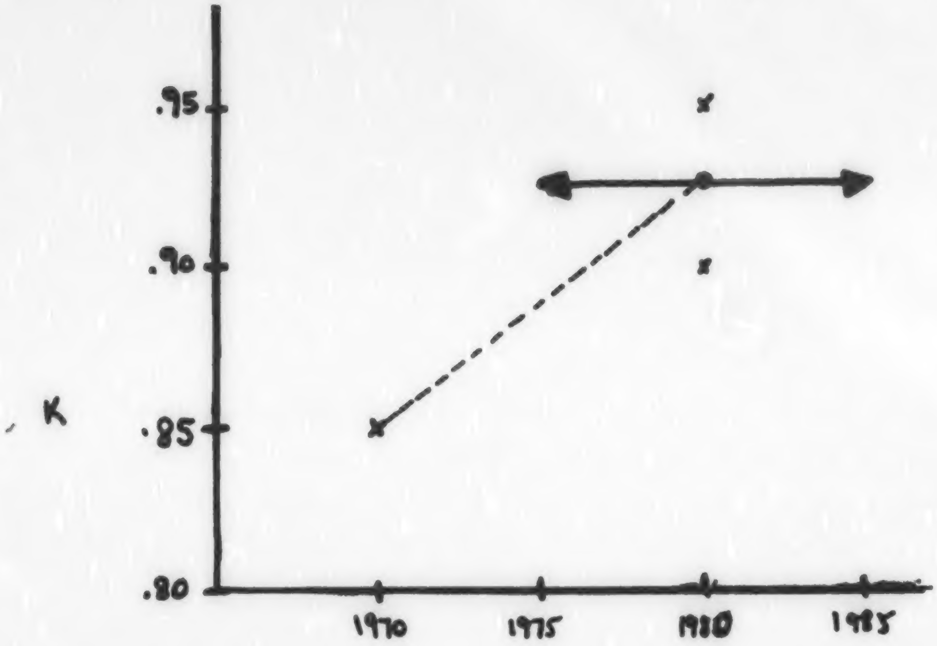
Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 8-19-74

Source Cast Iron Foundry (Furnaces)

K: Reference 07 p51 states that the 1970 production of gray iron casting was 17,923,000 TONS or about 85% of capacity. The estimated 1980 Prod/Cap ratios is expected to be 90 - 95%. same ref pg 51

We plot this information for better visualization.



We will take the simple average of 90 and 95% in 1980 and use this value to represent the typical K applicable over the 1975 - 1985 period

$\frac{90+95}{2} = 92.5 \Rightarrow$ assume K = .93

K = .93

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Massone Date 8-19-74

Source Cast Iron Foundry (Furnaces)

K: cont'd

The gray iron production is assumed to include the production of ductile and malleable iron.

Cast iron, which is the general termed used for casting manuf. having the characteristics of one of the above irons, is performed by melting metal scrap, rerun material, flux, etc in a Furnace. The three most commonly employed are;

(a) cupola
(b) electric arc
(c) induction

We will assume the utilization factor (K = .93) is the same industry wide.

Since the emission factors vary widely between furnaces and the growth rates are different for each, we are compelled to treat each separately, and employ individual values for A, P_c and P_B.

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Mazzone Date 8-19-74

Source Cast Iron Foundry (Furnaces)

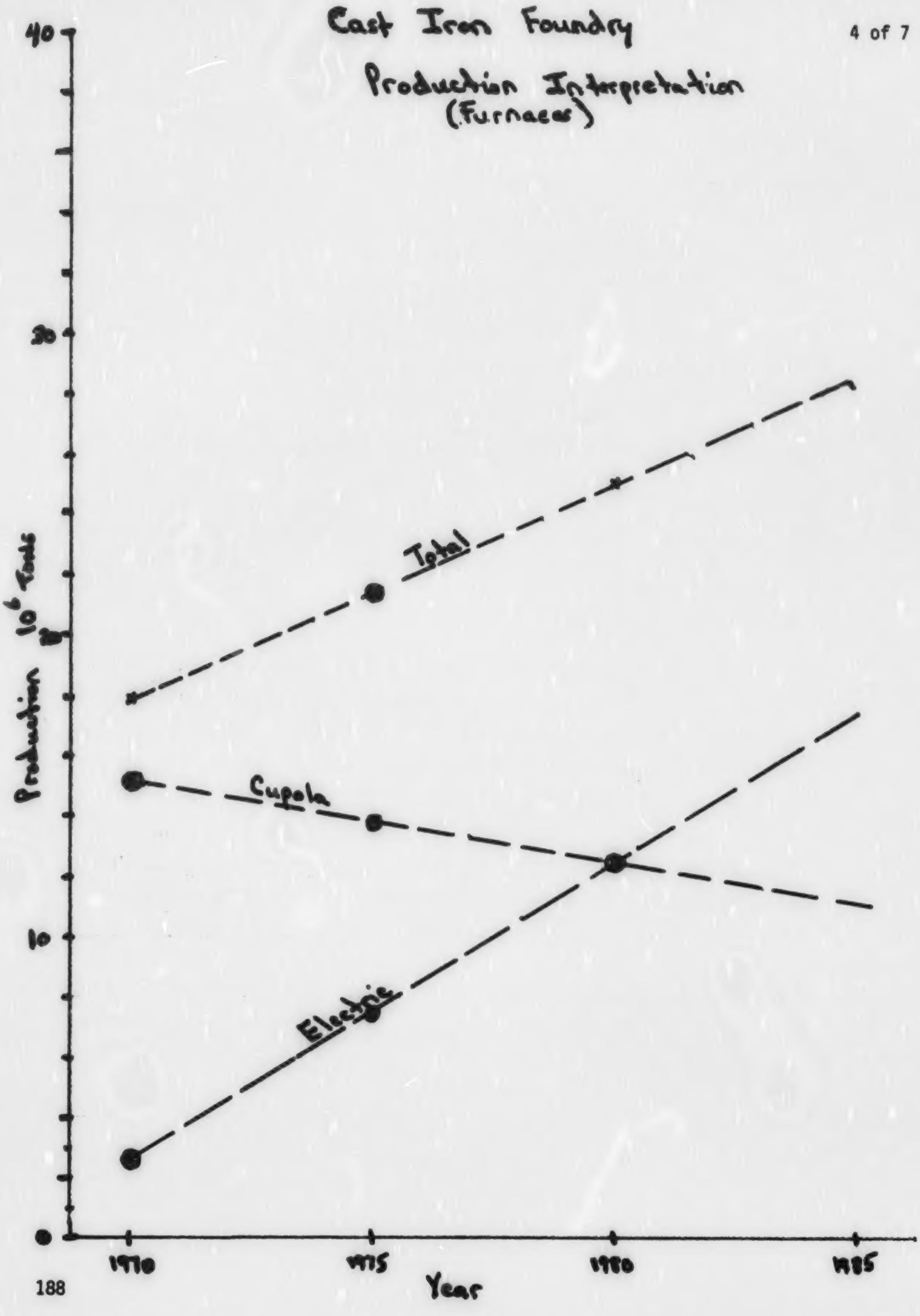
A: Ref 050 "Gray-Iron Foundries" pg 1 states that in 1970 90% of the metal poured for gray iron was done in cupolas.

Ref 067 pg II-11 vol I states that in 1969 85% of all iron metal melted was performed in cupolas. It goes on to project that only 50% of the total will be melted in cupolas; the balance being taken up by electric arc and induction. Reverberatory is implied to be a small source due to its small % of the production total.

We will assume that the 85% figure for 1969 applies to 1970 & is representative to the cast iron industry. It is believed that the 90% figure from Ref 050 represents gray iron only and not the ductile or malleable components combined (Total cast iron)

The attached Graph plots the total production information for the period 1970 - 1980 and the cupola and electric furnace prod. values.

The Total production is based on Ref 007 Table 8.1 pg 51 and the 85% (1970) cupola component and the 50% (1980) cupola component.



Cast Iron Foundry

Production Interpretation
(Furnaces)

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By William Marrone Date 8-19-74

Source Cast Iron Foundry (Furnaces)

A: cont'd

This industry will be divided into the cupola ~~[illegible]~~ and electric furnace processes.

Refering to the graph we prepared, we may obtain an estimate for the 1975 production figures of cupolas and electric furnaces. They were arrived at by straight-line interpolation between the data points plotted from information found in the literature as referenced previously.

1975 Production Total = 21.4×10^6 Tons/yr
1975 Cupola Production = 13.9×10^6 Tons/yr
1975 Electric Production = 7.5×10^6 Tons/yr

Applying the value of K = .93 we calculate the Production Capacities in 1975;

K = .93

$$A_{cupola} = \frac{13.9}{.93} \times 10^6$$

$$\boxed{A_{cupola} = 14.9 \times 10^6 \text{ Tons/yr}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By William Masson Date 8-19-74

Source Cast Iron Foundry (Furnaces)

A: cont'd

$$A_{electric} = \frac{7.5}{.93} \times 10^6$$

$$\boxed{A_{electric} = 8.1 \times 10^6 \text{ Ton/yr}}$$

P_c: We will take the growth of each of these to be represented by the simple growth above base year 1975. Use Production curves on attached graph.

$$P_c \text{ Cupola} = \frac{1980 - 1975}{1975} \div 5 = -.018 \text{ simple}$$

$$P_c = \frac{12.6 - 12.9}{12.9} \div 5 = -.018$$

$$P_c \text{ Electric} = \frac{1980 - 1975}{1975} \div 5 = .136 \text{ simple}$$

$$P_c = \frac{12.6 - 7.5}{7.5} \div 5 = .136$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By William Massone Date 8-19-74

Source Cast Iron Foundry (Furnaces)

$P_{B_{cupola}}$: As indicated in Ref 067 pg II-11 cupolas are being replaced industry-wide by electric furnaces. This trend is expected to continue undiminished, which would imply that replacement of existing equipment by cupolas is not expected. We therefore assume that $\boxed{P_{B_{cupola}} = 0}$

NOTE

Since the P_C for cupola is a negative value and the P_B was assumed to be 0, This particular source does not come under NSPS

$P_{B_{electric}}$:

Ref 037 pg 34 Section 33.1

Asset guideline period 18 yrs
P_B est → 2×IRS = 36 yrs

$\frac{100\%}{36\text{ yrs}} \cong 2.8\%/\text{yr}$ simple

$$\boxed{\therefore P_{B_{electric}} = .028 \text{ simple}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 8-20-74

Source Cast Iron Foundry (Furnaces)

We have concluded that there is a decline in the cupola capacity (negative growth) and no replacement of obsolete capacity ($P_B = 0$) so that Cupola Furnaces would not be considered under NSPS.

Emission factors will be developed for the Electric furnaces.

Particulate

E_u : Ref 075 Table 7.10-1 pg 7.10-1

Electric Arc: E_u = 1.5 lb/TON metal

Ref 145 pg 216

Electric Arc 5-10 lb/TON metal

We will use average value for an emission factor from electric furnaces

$$E_u = \frac{\frac{5+10}{2} + 1.5}{2} = 4.5 \text{ lb/TON}$$

$$\boxed{\therefore\ E_{\underset{\text{electric}}{u}} = 4.5 \text{ lb/TON metal}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By William Massone Date 8-19-74

Source Cast Iron Foundry (Furnaces)

E_N : Ref 050 "Gray Iron Foundry" pg 4-5

Control for Electric Arc Furnace are mostly baghouses 95 -99+ eff

No control information for Electric Induction was found.

We assume an attainable efficiency for both types of electric furnaces to be 99% which will be applied to the whole electric furnace portion of the Cast Iron Foundry industry

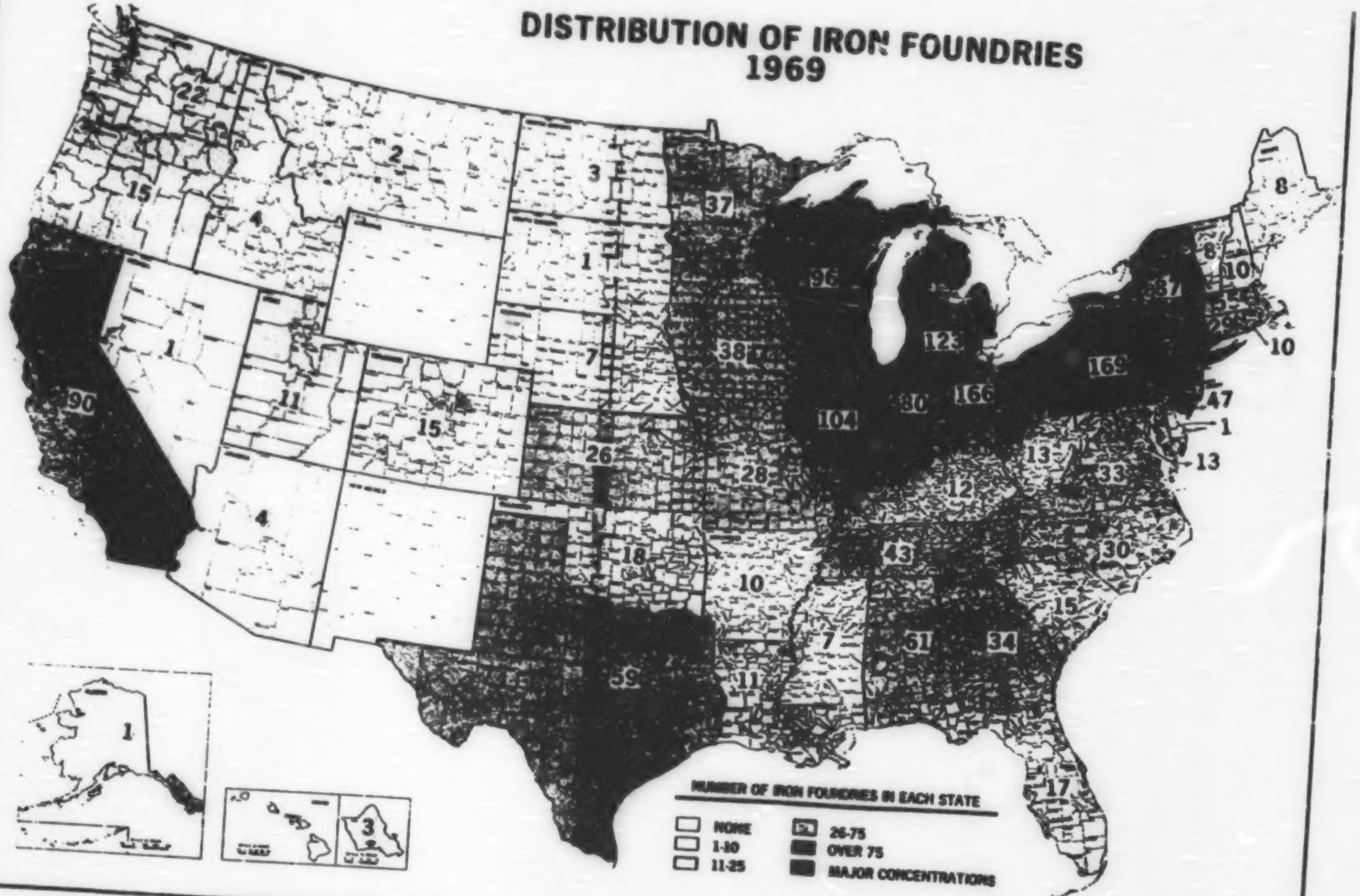
$E_N = .01 \times E_u = .01 \times 4.5 = .045$ lb/TON

$\therefore$

$$\boxed{E_{N_{\text{electric}}} = .045 \text{ lb/TON metal}}$$

Ref 068

DISTRIBUTION OF IRON FOUNDRIES
1969


22
15
2
4
3
1
7
1
11
15
4
90
26
18
59
37
38
28
10
11
7
96
104
80
123
166
169
13
12
43
61
34
33
30
15
17
87
8
10
8
55
29
10
47
1
13
1
3
NUMBER OF IRON FOUNDRIES IN EACH STATE
NONE
1-10
11-25
26-75
OVER 75
MAJOR CONCENTRATIONS

SOURCE: PENTON PUBLISHING CO.

A

B

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Computation Sheet For Emission Factors

Calculations Done By R. J. Londergan Date 10-24-74

Source Cast Iron Foundry

Particulates

Using the information presented on p. 4 of the production factors calculation, electric furnace production in 1970 was 2.7 x 10⁶ TONS. From Ref. 007, p. 52, we see that there were a total of 1040 electric furnaces in operation in 1970. The process weight rate (average) is therefore

$$\frac{2.7 \times 10^6 \text{ TON/YR}}{1040 \text{ furnaces}} \times \frac{1 \text{ YR}}{365 \text{ day}} \times \frac{1 \text{ day}}{16 \text{ hr.}} \times \frac{2000 \text{ LB}}{\text{TON}} \cong 900 \text{ LB/HR}$$

assuming a 16-hour/day average utilization. No geographic distribution for electric furnaces is available, so we utilize the 50-state average allowable emissions curves, as discussed in Vol # 1. The resulting allowable emissions rate is 2.4 LB/HR, corresponding to

$$E_S = (2.4 \text{ LB/HR}) / (.45 \text{ TON/HR}) = 5.3 \text{ LB PT.}/\text{TON IRON}$$

This ~~[illegible]~~ ~~exceeds~~ value ~~factor~~ is larger than E_{cc}; therefore we have

$$\boxed{E_S = E_{cc} = 4.5 \text{ LB/TON}}$$

since E_S cannot in fact be larger than E_{cc}.

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Computation Sheet For Industrial Factors

Calculations Done By [illegible] Date 9/4/74

Source SECONDARY COPPER

1970 PRODUCTION = 1257 x 10³ TONS REF (95) 233.4530

GROWTH 1960-1970 REF (95) 233.4530

$$P_c = \sqrt[10]{\frac{1257}{8744}} - 1.0 = 3.74\%$$

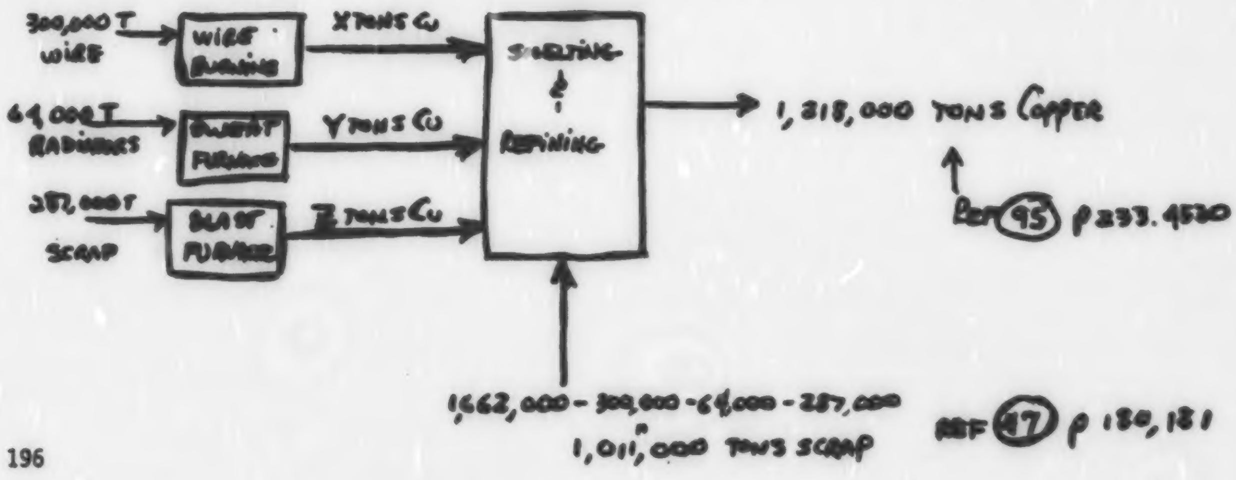
$$\boxed{P_c = 3.74\% \text{ compound}}$$

EMISSIONS ARE THE RESULT OF
① MATERIALS PREPARATION REF (49) p 406
② SMELTING & REFINING TAB 19-1

(49)
REF ●
p406 TAB 19-1

EMISSION FACTORS ARE PRESENTED ON THE BASIS OF UNIT WEIGHT OF SCRAP NOT UNIT WEIGHT OF COPPER PRODUCED. THE FOLLOWING FLOW CHART MAY HELP IN REDEFINING EMISSION RATES AND DETERMINING BREAKDOWNS IN "A".

1968 VALUES


300,000 T WIRE
WIRE BURNING
X TONS Cu
64,000 T RADIATORS
SWEAT FURNACE
Y TONS Cu
287,000 T SCRAP
BLAST FURNACE
Z TONS Cu
SMELTING & REFINING
1,318,000 TONS COPPER
REF (95) p 233.4530
1,662,000 - 300,000 - 64,000 - 287,000
= 1,011,000 TONS SCRAP
REF (47) p 180, 181

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/13/74

Source Secondary Copper

Ref (47) p 131 states various % combustibles for wire. The avg is about 26% or 74% Copper

$$\left(300{,}000 \ \frac{\text{tons}}{\text{wire}}\right)\left(.74 \ \frac{\text{tons copper}}{\text{ton wire}}\right) = X \text{ tons Cu} = 222{,}000 \ \text{tons Cu}.$$

Ref (59) p 116 states 60% as the recoverable percent of aluminum in scrap used in sweating furnaces. We will assume this % for copper used in sweating furnaces.

$$\left(64{,}000 \ \text{tons Rad's}\right)\left(0.6 \ \frac{\text{tons Cu}}{\text{ton Rad}}\right) = Y \text{ tons Cu} = 38{,}400 \ \text{tons Cu}$$

Ref (46) p 302 states 70% as the recoverable percent of lead from scrap used in blast furnaces. We will assume this % for copper used in blast furnaces.

$$\left(287{,}000 \ \text{tons scrap}\right)\left(0.7 \ \frac{\text{tons Cu}}{\text{ton scrap}}\right) = 200{,}900 \ \text{tons Cu}$$

$$\Sigma \text{ Copper} = 461{,}300 \text{ tons } 1968$$

Assume to be same as the whole industry

1975 "Production" copper output from mat'ls handling $= \left(0.4613 \times 10^6 \text{ tons}\right)\left(1.0374\right)^7 = 0.596 \times 10^6 \text{ tons}$

No direct information regarding "K" could be located other than DOC statistics on capacity utilization rates for "advanced processed non-ferrous metals". The average "K" for 1965-1973 is 82%

$\boxed{K = 0.82}$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/12/74

Source Secondary Copper

$$A_{\text{mattes handling}} = \frac{0.596\times10^6 \text{ TONS}}{0.82} = 0.727\times10^6$$

$$\boxed{A_{\text{copper mattes handling}} = 0.727\times10^6 \text{ Tons}}$$

$$A_{\text{copper smelting \& refining}} = \frac{(1.257\times10^6)(1.0374)^5}{0.82} = 1.842\times10^6 \text{ Tons}$$

$$\boxed{A_{\text{copper smelting \& refining}} = 1.842\times10^6 \text{ Tons}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-26-74

Source Secondary Copper

P_B: Ref 037 pg 34 section 33.2

Asset guideline life 14 yrs.

P_B est = 2×IRS 28 yrs.

$$\frac{100\%}{28\text{ yrs.}} \cong \underset{\text{simple}}{3.5\%}/\text{yr}$$

$$\therefore P_B = .035 \text{ simple}$$

We assume that the value of P_B is applicable to both the material handling and smelting/refining operations of this industry.

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/12/74

Source Secondary Copper

As mentioned on p1 of the calculation sheet for industrial factors, emission factors are presented on the basis of unit weight of scrap, not unit weight of copper produced.

Ref ㊾ p406 Tab 19-1

A. Materials Preparation

① Wire burning - 275 #/ton scrap
② Sweating furnaces - 15 #/ton scrap
③ Blast furnaces - 50 #/ton scrap

From p2 of industrial factor calc'n sheet

$$0.74 \ \frac{\text{TONS Cu}}{\text{TON WIRE}} \Rightarrow \frac{275}{0.74} = 372 \ \#/\text{TON Cu}$$

$$0.6 \ \frac{\text{TONS Cu}}{\text{TON RAD'S}} \Rightarrow \frac{15}{0.6} = 25 \ \#/\text{TON Cu} \ (\text{Sweating})$$

$$0.7 \ \frac{\text{TONS Cu}}{\text{TON SCRAP}} \Rightarrow \frac{50}{0.7} = 71.4 \ \#/\text{TON Cu} \ (\text{Blast})$$

Also from p2

222,000 TONS CU FROM WIRE — 48 %
38,400 TONS CU FROM SWEATING FURNACES — 8 %
200,900 TONS CU FROM BLAST FURNACES — 44 %
461,300 TONS TOTAL

$$\bar{E}_{U_{\text{HANDLING}}} = 372(.48) + 25(.08) + 71.4(.44)$$

$$= 179 + 2 + 31.4$$

$$\boxed{E_{UP_{\text{HANDLING}}} = 212 \ \#/\text{TON COPPER}}$$

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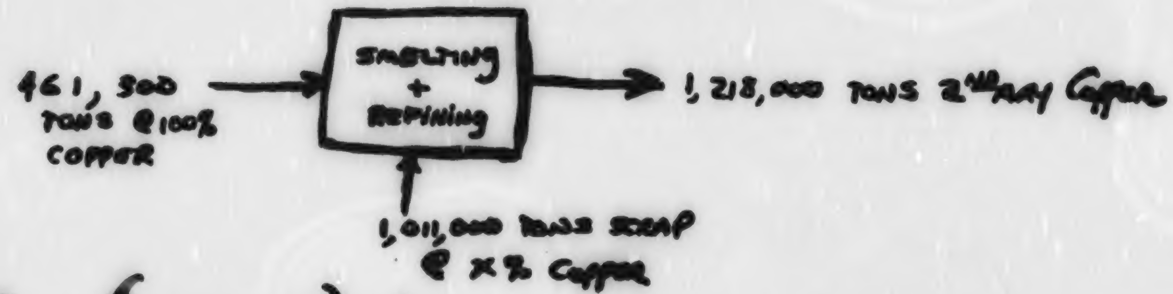
Computation Sheet For Emission Factors

Calculations Done By Homer Date 9/12/74

Source SECONDARY COPPER

REF ㊾ p 406 TAB 19-1 gives

$$EU_{\substack{\text{SMELT.}\\ \text{&REF}}} = 70 \text{ \#/TON SCRAP}$$


461,300 TONS @100% COPPER
SMELTING + REFINING
1,218,000 TONS 2ndARY COPPER
1,011,000 TONS SCRAP @ X% COPPER

$$\Sigma_{\text{INPUT}} = (1.011 + .4613)10^6 \text{ TONS "SCRAP"} = 1.4723\times10^6$$

$$\frac{\text{TONS COPPER}}{\text{TON SCRAP INPUT}} = \frac{1.218\times10^6}{1.4723\times10^6} = 0.827$$

$$\therefore EUP_{\substack{\text{SMELT}\\ \text{&REF}}} = 70/0.827 = 84.6 \text{ \#/TON Cu}$$

$$\boxed{EUP_{\substack{\text{SMELTING}\\ \text{&}\\ \text{REFINING}}} = 84.6 \text{ \#/TON COPPER}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/23/74

Source Secondary Copper

REF ㊾ p 415 STATES AN efficiency of 99.6% has been achieved with A baghouse - the only generally ACCEPTED COLLECTION DEVICE.

$$E.N_p = E_U(1-.996) = E_U(.004)$$

$$\boxed{EN_{P_{\text{handling}}} = 0.848 \text{ \#/TON COPPER}}$$

$$\boxed{EN_{P_{\text{smelt + refining}}} = 0.338 \text{ \#/TON COPPER}}$$

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Computation Sheet For Emission Factors

Calculations Done By V.F. Russo Date 10/21/74

Source Secondary Copper

Particulates:

Ref 155 states for 1967 that 42 plants are in the 2nd dary Copper Industry. Assuming each plant performs all of the functions (i.e. wire burning, sweating, blast furnace, smelting and refining).

Wire Burning

300,000 T Wire yeilds 222,000 Tons Cu (See previous analysis)

For single Pl. Process Wgt. Rate $= \dfrac{300{,}000 \text{ Tons/YR } 2000 \text{ lbs/TON}}{(42)\ 8760 \text{ HRS/YR}}$

$\cong 1630$ lbs/HR

Allowable Emissions (50 State Numerical Average) = 3.60 lbs/HR Particulate

Copper Production per hour $= \dfrac{222{,}000 \text{ Tons} \times 2000 \text{ lbs/TON}}{(42)\ 8760}$

$\cong 1206$ lbs/HR $= 0.603$ TONS/HR

For wireburn $E_S^{\circ} = \dfrac{3.60 \text{ lbs/HR}}{.603 \text{ TONS/HR}} = 5.97$ lbs Part/TON Cu

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By U.F. Russo Date 10/21/74

Source Secondary Copper

Radiators

64,000 Tons yeilds 38,400 Tons Cu

For single plant Process Wgt. Rate = $\dfrac{64{,}000\ \text{TON}/\text{YR}\ \ 2000\ \text{lbs}/\text{TON}}{(42)\ (8760)}$

$\cong 350\ \text{lbs}/\text{HR}$ (also $.174\ \text{TONS}/\text{HR}$)

Allowable Emissions (50 State Average) = 1.25 lbs Part./HR

Copper Production = $\dfrac{38{,}400\ \text{TONS}/\text{YR}\ \ 2000\ \text{lbs}/\text{TON}}{(42)\ (8760)}$

$= 208.74\ \text{lbs}/\text{HR} = .104\ \text{TONS}/\text{HR}$

$$E_s^0 = \frac{1.25\ \text{lbs Part.}/\text{HR}}{.104\ \text{TON Cu}/\text{HR}} = 12.02\ \text{lbs Part.}/\text{TON Cu.}$$

Blast Furnace

287,000 Tons Yeilds 200,900 Tons Cu

Single Plant Process Wgt. Rate = 1560 lbs/HR

Allowable Emissions (50 State Average) = 3.5 lbs Part./HR

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By V. Russo Date 10/21/74

Source Secondary Copper

$$\text{Copper Production} = \frac{200,900 \text{ TON Cu/YR}}{(42)\ 8760 \text{ HR/YR}}$$

$$= 0.546 \text{ TONS/HR}$$

$$E_S^0 = \frac{3.5 \text{ lbs/HR}}{.546 \text{ TONS/HR}} = 6.41 \text{ lbs Part./TON Cu}$$

For handling

$$E_S^{\text{Handling}} = 5.97\,(.48) + 12.02\,(.08) + 6.41\,(.44)$$

$$= 2.86 + 0.96 + 2.82$$

$$\boxed{E_S^{\text{Handling}} = 6.64 \text{ lbs Part/TON Cu.}}$$

SMELTING & REFINING

1.4723×10^6 TONS Yeilds 1.218×10^6 Tons 2nd ary Cu

For Single Plant Process Wgt. Rate = 8000 lbs/HR

Allowable Emissions (50 State Average) = 11.5 lbs/HR

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Computation Sheet For Emission Factors

Calculations Done By V. F. Russo Date 10/21/74

Source Secondary Copper

$$\text{Cu Production} = \frac{1.218 \times 10^6 \text{ TONS Cu}}{(42)(8760)}$$

$$= 3.31 \ \text{TONS}/\text{HR}$$

$$\boxed{E_S^{\text{SMELTING \& REFINING}} = \frac{11.5 \ \text{lbs}/\text{HR}}{3.31 \ \text{TONS}/\text{HR}} = 3.47 \ \text{lbs. Part}/\text{TON Cu}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/6/74

Source SECONDARY LEAD

PRODUCTION IN 1971 = 555×10^3 TONS REF (95)
p 233. 4830

REF ㊹ p 41 STATES

$$\boxed{P_C = 3.2\%}$$ ASSUME CMPD

REF ㊹ p41 STATES

2 new plants/year
1-2 plants will be modified

Assume that the capacity of a modified plant equals the capacity of a new plant. Then

$$P_B = \frac{1.5}{2}(3.2\%) = 2.4\%$$

$$\boxed{P_B = 2.4\%}$$ Assume simple

Ref ㊹ p 39 States typical plant capacity = 50 TPD
" " p 41 States 45 operating plants in 1971

Assuming 365 D/YR OP'N

$$\left(45 \text{ plants}\right)\left(50 \frac{\text{TONS}}{\text{DAY/PLANT}}\right)\left(365 \frac{\text{DAYS}}{\text{YR}}\right) = \underset{1971}{\text{Capacity}} = 821.3 \times 10^3 \text{ TONS}$$

$$K = \frac{\text{PROD}}{\text{CAP}} = \frac{555 \times 10^3}{821.3 \times 10^3} = 0.68$$

$$\boxed{K = 0.68}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoose Date 9/6/74

Source Secondary Lead

$$A = \frac{(555\times10^3)}{(0.68)} \times (1.032)^4 = 0.926\times10^6 \text{ TONS}$$

$$\boxed{A_{TOTAL} = 0.926\times10^6 \text{ TONS}}$$

SECONDARY LEAD is produced by one of three PROCESSES

ⓐ POT FURNACES
ⓑ BLAST FURNACES (CUPOLAS)
ⓒ REVERBATORY FURNACES

IT APPEARS AS though emissions differ for each, so well will break up "A" accordingly & ASSUME K, Pc & Ps to hold for ALL three CASES.

REF ㊾ STATES (p406 TAB 19-1) the following breakdown, in terms of scrap feed, to each process

			%
POT	53,000	—	7 %
BLAST	119,000	—	16 %
REVERB.	554,000	—	77 %
TOTAL	726,000		

Assuming that this breakdown holds for output as well as input.

$$\boxed{\begin{aligned} A_{POT} &= 0.065\times10^6 \text{ TONS} \\ A_{BLAST} &= 0.148\times10^6 \text{ TONS} \\ A_{REVERB} &= 0.713\times10^6 \text{ TONS} \end{aligned}}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 9/16/74

Source Secondary Lead

PARTICULATES

BLAST FURNACES

REF ㊾ p406 TAB 19-1

$E_v = 190 \frac{\#}{\text{TON SCRAP}}$

We need this value in terms of lead product, not scrap

REF ㊾ p 302 STATES

$\frac{\#\text{LEAD}}{\#\text{CHARGE}} = 0.70$

$190 \frac{\#}{\text{TON SCRAP}} \times \frac{1 \text{ TON SCRAP}}{0.7 \text{ TON LEAD}} = 271$

$\boxed{EU_{P_{BLAST}} = 271 \frac{\#}{\text{TON LEAD}}}$ ← TOTAL PARTICULATE

REF ㊹ p 37 STATES that the % OF LEAD IN THE EMISSION IS 63%

$\therefore \boxed{EU_{Pb_{BLAST}} = 171 \frac{\#}{\text{TON LEAD}}}$

REVERBATORY FURNACES

REF ㊾ p 406 TAB 19-1

$E_v = 130 \frac{\#}{\text{TON SCRAP}}$

REF ㊾ p 300 STATES

$\frac{\#\text{LEAD}}{\#\text{CHARGE}} = 0.47$

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Computation Sheet For Emission Factors

Calculations Done By ______________ Date 9/9/74

Source SECONDARY LEAD

$$EU_{P_{REVERB}} = \frac{130}{0.47} = 277$$

$$\boxed{EU_{P_{REVERB.}} = 277 \frac{\#}{\text{TON LEAD}}} \leftarrow \text{TOTAL PARTICULATE}$$

¢

FOR A LEAD CONCENTRATION OF 63 %

$$\boxed{EU_{Pb_{REVERB}} = 175 \frac{\#}{\text{TON LEAD}}}$$

POT

REF ㊾ p406 TAB 19-1

$$EU = 0.8 \frac{\#}{\text{TON SCRAP}}$$

$$EU_{P_{POT}} = \frac{0.8}{0.59} = 1.36$$

$$\boxed{EU_{P_{POT}} = 1.36 \frac{\#}{\text{TON LEAD}}}$$

FOR 63% LEAD

$$\boxed{EU_{Pb_{POT}} = 0.857 \frac{\#}{\text{TON LEAD}}}$$

NO % LEAD RELATION--SHIP COULD BE FOUND IN THE LIT--ERATURE.
ASSUME AVG OF OTHER TWO METHODS THIS APPEARS REASONABLE SINCE POT FURNACES FURNISH ONLY 7% OF THE TOTAL LEAD

$$\frac{0.7 + .47}{2} = .59$$

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Computation Sheet For Emission Factors

Calculations Done By ______________________ Date 9/9/74

Source SECONDARY LEAD

SULFUR DIOXIDE

REVERBATORY

REF (49) p 427 TAB 19-10 STATES

ⓐ 0.104% SO_2 for 2500 #/HR (SCRAP) plant
ⓑ 10,400 SCFM

$$\frac{\#\,SO_2}{\text{TON LEAD}} = \frac{\left(0.00104\ \frac{FT^3\,SO_2}{FT^3\,GAS}\right)\left(10{,}400\ \frac{FT^3\,GAS}{MIN}\right)\left(530\ {}^\circ R\right)\left(64\ \frac{\#\,SO_2}{\#\,MOLE}\right)\left(60\ \frac{MIN}{HR}\right)}{\left(492\ {}^\circ R\right)\left(359\ \frac{FT^3\,SO_2}{\#\text{-}MOLE}\right)\left(2500\ \frac{\#\,LEAD}{HR}\right)\left(0.47\right)\left(\frac{\text{TON LEAD}}{2000\ \#\,LEAD}\right)}$$

$$= 212\ \frac{\#\,SO_2}{\text{TON LEAD}}$$

$$\boxed{Eu_{SO_2\ REVERB} = 212\ \frac{\#}{\text{TON LEAD}}}$$

BLAST REF (49) p 427 TAB 19-10 STATES

ⓐ 0.03 % SO_2 for 2670 #/HR (SCRAP) plant
ⓑ 13,000 SCFM

$$\frac{\#\,SO_2}{\text{TON LEAD}} = \frac{(.0003)(13000)(530)(64)(60)(2000)}{(492)(359)(2670)(.7)} = 48$$

$$\boxed{Eu_{SO_2\ BLAST} = 48\ \frac{\#}{\text{TON LEAD}}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOMER Date 9/9/74

Source SECONDARY LEAD

NO MENTION of SO_x emissions from pot furnaces could be found in THE LITERATURE. THEREFORE, for THE PRESENT, WE WILL ASSUME

$$\boxed{EU_{\substack{SO_2\\POT}} = 0}$$

CARBON MONOXIDE

REF ㊶ p 37 STATES

See pages 14 & 15 of these CALCS. FOR ADDITIONAL CO CALCULATIONS

"AN AFTERBURNER IS NOT NEEDED IN THE REVERBERATORY FURNACE SINCE THE EXCESS AIR AND TEMPERATURE ARE SUFFICIENT TO INCINERATE CARBON MONOXIDE AND HYDROCARBONS."

$$\therefore \boxed{EU_{\substack{CO\\REVERB}} = EN_{CO} = 0}$$

REF ⑱ "THE QUANTITY OF AIR CONTAMINANTS ... POT FURNACES .... IS MUCH LESS THAN THAT FROM REVERBATORY OR BLAST FURNACES" p 424 $\boxed{EU_{\substack{CO\\POT}} = 0}$

MANY REFERENCES STATE CO emissions to be A PROBLEM IN BLAST FURNACES. "NONE," HOWEVER TELL WHAT ONE MIGHT EXPECT IN TERMS OF EMISSION LEVELS.

REF (89) p 37 REFERS to AN A/B AS A CONTROL METHOD. (MANY REFERENCES make the same claims.) Since an A/B is nearly 100% EFFICIENT IN CONVERTING $CO \rightarrow CO_2$, WE WILL ASSUME

$$\boxed{EN_{CO_{BLAST}} = 0}$$

$$\boxed{EU_{CO_{BLAST}} = ?}$$

UNTIL BETTER EU INFO CAN BE DEVELOPED

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/27/74

Source 2° LEAD

SEE pages 15-18 of these calc's for factors regarding NOx.

9/9/74

Ref ㊶ p 37 indicates a control efficiency of 97% on an average emission of 35 #/TON LEAD for blast and reverb furnaces using a baghouse or high energy scrubber

$$E_N = 35(1-.97) = 1.05 \ \text{LB/TON}$$

$$\boxed{E_{N_{P}\ \text{BLAST}} = 1.05 \ \text{\#/TON LEAD}} \leftarrow \text{TOTAL PARTICULATE}$$

$$E_{N_{\substack{\text{BLAST}\\ Pb}}} = 1.05(0.63) = 0.662$$

$$\boxed{E_{N_{\substack{\text{BLAST}\\ Pb}}} = 0.662 \ \text{\#/TON LEAD}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoake Date 9/9/74

Source 2° LEAD

Reverb

$$\boxed{E_{N_{\substack{\text{Reverb}\\ p}}} = 1.05 \text{ \#/ton lead}} \leftarrow \text{TOTAL PARTICULATE}$$

$$\boxed{E_{N_{\substack{\text{Reverb}\\ Pb}}} = 0.662 \text{ \#/ton lead}}$$

Pot

Applying the same efficiency to pot furnaces as blast & reverb,

$$E_{N_{\substack{\text{pot}\\ p}}} = 1.36(1-.97) = .041$$

$$\boxed{E_{N_{\substack{\text{pot}\\ p}}} = 0.041 \text{ \#/ton lead}} \leftarrow \text{TOTAL PARTICULATE}$$

$$E_{N_{\substack{\text{pot}\\ Pb}}} = .041(.63) = 0.026$$

$$\boxed{E_{N_{\substack{\text{pot}\\ Pb}}} = 0.026 \text{ \#/ton lead}}$$

SOx Ref ⑮ p 7.11-2 TAB 7.11-1

$$\eta_{\substack{SO_x\\ \text{blast}}} = \frac{90-.8}{90} = 99\% \text{ with NaOH scrubber}$$

$$E_{N_{\substack{SO_x\\ \text{blast}}}} = 48(1-.99) = 0.48 \text{ \#/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 9/10/74

Source SECONDARY LEAD

$$E_{N_{SO_x \text{ BLAST}}} = 0.18 \frac{\#}{\text{TON LEAD}}$$

ASSUMED SAME efficiency for Reverb furnace SO_2 removal system.

$$E_{N_{SO_x \text{ REVERB}}} = 2.12 \frac{\#}{\text{TON LEAD}}$$

SUMMARY

	E_U			E_N		
	BL.	REVERB.	POT	BL.	REVERB	POT
TOTAL PART.	271	277	1.86	1.05	1.05	0.041
LEAD PART.	171	175	0.857	0.66	0.66	0.026
SO_x	48	212	[0]	0.48	2.12	[0]
CO	[?]	0	[0]	[0]	0	[0]
NO_x	[0]	[0]	[0]	[0]	[0]	[0]

[ ] NEED DATA to PROVE OR MORE DEFINITIVE NUMBERS

SEE p 19 for A final summary. Do not use the above values.

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/27/74

Source 2° LEAD

It is felt that either a baghouse or high energy scrubber can be retrofit to existing installations. Therefore,

$$E_{111d} = E_N$$

$$\boxed{E_{\substack{111(d)\\ Pb \\ Blast}} = 0.662 \ {}^{LB}/_{TON\ LEAD}}$$

$$\boxed{E_{\substack{111(d)\\ Pb \\ Reverb}} = 0.662 \ {}^{LB}/_{TON\ LEAD}}$$

$$\boxed{E_{\substack{111(d)\\ Pb \\ Pot}} = 0.026 \ {}^{LB}/_{TON\ LEAD}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/5/74

Source Secondary Lead

PARTICULATE Es

FOR 1971, REF ㊷ p406 gives the following:

Pot 53,000 TONS (7%)
Blast 119,000 TONS (16%)
Reverb 554,000 TONS (77%)

} of SCRAP

Ref ㊹ STATES 45 plants in 1971
Assuming that 7% of the plants use pot furnaces, 16% use blast furnaces and 77% use reverb furnaces, the typical hourly production rates are....

$$\text{Pot} = \frac{53{,}000}{(.07)(45)(8760)} = 1.9207 \text{ TPH of scrap}$$

$$\text{Blast} = \frac{119{,}000}{(.16)(45)(8760)} = 1.8867 \text{ TPH of scrap}$$

$$\text{Reverb} = \frac{554{,}000}{(.77)(45)(8760)} = 1.8252 \text{ TPH of scrap}$$

Converting to #/HR capacity & using REFS (84) & ㊽ (TO GET the generalized PWR curve)

Pot — 5649 pph — 8.6 #/HR allowable
Blast — 5549 pph — 8.4 " "
Reverb — 5368 pph — 8.1 " "

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Computation Sheet For Emission Factors

Calculations Done By Hoaser Date 12/5/74

Source Secondary Lead

Es for Particulates

For Blast furnaces $\frac{\#LEAD}{\#CHARGE} = 0.7$

So $\#/HR$ of 2° LEAD PRODUCT FOR PLANT $= 5649\,(.7) = 5954\ \#/HR = 1.977$ TPH

- - - - -

For Reverb furnaces, $\#LEAD/\#CHARGE = .47$

$= 5549\,(.47) = 2608\ \#/HR = 1.304$ TPH

- - - - -

For Pot furnaces, $\#LEAD/\#CHARGE = .59$

$= 5368\,(.59) = 3167 = 1.584$ TPH

$$\left.\begin{aligned}
Es_{\underset{P}{BLAST}} &= \frac{8.6}{1.977} = \boxed{4.35\ \#/\text{TON LEAD} = Es_{P_{\underset{EXIST}{BLAST}}}}\\
Es_{\underset{P}{Reverb}} &= \frac{8.4}{1.304} = \boxed{6.44\ \#/\text{TON LEAD} = Es_{P_{\underset{EXIST}{Reverb}}}}\\
Es_{\underset{P}{POT}} &= \frac{8.1}{1.584} = \boxed{5.11\ \#/\text{TON LEAD} = Es_{P_{\underset{EXIST}{POT}}}}\,{}^{*}
\end{aligned}\right\}\ \text{FOR EXISTING INSTALLATIONS}$$

For new installations, for blast & reverb furnaces, the regulation is 0.022 gr/dscf (Ref ⑪ p27).

---

* Since this is greater than EU, we will set EU = Es

$$\therefore \boxed{Esp_{\underset{EXIST}{POT}} = 1.36\ \#/\text{ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/5/74

Source 2° Lead

Ref ㊹ p37 indicates that this regulation would correspond to an emission rate of 26 #/hr for a 50TPD plant

$$Es_{P_{NEW}} = \frac{2.6(24)}{50} = 1.25$$

$$\boxed{Es_{P_{\substack{NEW\\BLAST/REVERB}}} = 1.25 \ \#/\text{TON LEAD}}$$

Regs for Pot furnaces are based on opacity only. State control would satisfy the reg'n $\therefore Es_{NEW} = Es_{EXIST}$ Actually Ev is below Es

There are no specific regs for Pb emissions. However, de facto control of Pb is accomplished through control of particulate emissions. Therefore, since the emission is particulate matter is 63% Pb, Es for Pb would be 63% of the Es for particulates.

$$\boxed{Es_{\substack{BLAST\\Pb\\EXIST}} = 2.74 \ \#/\text{TON Pb}}$$

$$\boxed{Es_{\substack{REVERB\\Pb\\EXIST}} = 4.06 \ \#/\text{TON Pb}}$$

$$\boxed{Es_{\substack{POT\\Pb\\EXIST}} = 0.86 \ \#/\text{TON Pb}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/5/74

Source 2° LEAD

$$\boxed{E_{s_{\substack{\text{BLAST}\\ \text{Pb}\\ \text{NEW}}}} = 0.788 \ \text{\#/TON Pb}}$$

$$\boxed{E_{s_{\substack{\text{REVERB}\\ \text{Pb}\\ \text{NEW}}}} = 0.788 \ \text{\#/TON Pb}}$$

$$\boxed{E_{s_{\substack{\text{POT}\\ \text{Pb}\\ \text{NEW}}}} = 0.86 \ \text{\#/TON PB}}$$

Es summary for Part's & Lead

	PARTICULATE		LEAD	
	EXISTING	NEW	EXISTING	NEW
Blast	4.35	1.25	2.74	0.79
Reverb	6.44	1.25	4.06	0.79
Pot	1.36	1.36	0.86	0.86

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/13/74

Source 2° LEAD

SO_2 E_s

Three states have SO_2 regs. which would be applicable to 2° Pb plants (Ref ㉞ & (148))

Ill. 2000 ppm
Ind. $19.5\,(P)^{.67}$
N.J. 2000 ppm

For Reverb furnaces, the uncontrolled SO_2 emissions are 1040 ppm (See p 3 of these calcs) ∴ $E_s = E_v$ in Ill. & N.J.

For Blast furnaces, the uncontrolled SO_2 emissions are 300 ppm ∴ $E_s = E_v$ in Ill. & N.J.

Typical PWR for all furnaces = 1.90 TPH (see p 8)

$$\text{Allow Ind} = \frac{19.5(1.90)^{.67}}{(1.90)\underset{\substack{\uparrow \\ \text{Reverb}}}{(.47)}} = \frac{(1.534)(19.5)}{(1.90)(.47)} = 33.5\ \frac{\#\,SO_2}{\text{ton Pb}}\ (\text{Reverb})$$

$$= \frac{(19.5)(1.90)^{.67}}{(1.90)\underset{\substack{\uparrow \\ \text{Blast}}}{(.70)}} = 22.4\ \#\,SO_2/\text{ton Pb}\ (\text{Blast})$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/13/74

Source 2° LEAD

Based on capacity apportioned according to value added from Ref ⑮⑸ for the entire 2° metals industry (SIC 3341), 5.5% of the industry is located in Indiana

So

$$Es_{SO_2\,REVERB} = (.055)(33.5) + 212(1-.055) = 200.34 + 1.84$$

$$\boxed{Es_{SO_2\,REVERB} = 202\ \#/_{\text{TON LEAD}}}$$

$$Es_{SO_2\,BLAST} = (.055)(22.4) + 48(1-.055) = 45.36 + 1.23$$

$$\boxed{Es_{SO_2\,BLAST} = 46.6\ \#/_{\text{TON LEAD}}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/26/74

Source 2° Lead

CO

(a) Blast Furnaces

From Ref (236) p VI-59 "Lead blast furnaces or cupolas are very similar to the cupolas utilized in the grey iron foundry industry." We will assume CO emissions to be the same as for grey iron blast furnaces.

Ref (75) p 7.10-1 TAB 7.10-1

$$E_{U_{CO}} = 145 \ \#/\text{ton metal charged}$$

From pg of these calcs $\left.\frac{\#\text{LEAD}}{\#\text{CHARGE}}\right)_{BLAST} = 0.7$

$$E_{U_{CO}} = \frac{145}{0.7} = 207$$

$$\boxed{E_{U_{CO\,BLAST}} = 207 \ \#/\text{TON LEAD}}$$

Ref (75) p 7.10-1

A well-designed afterburner can control emissions to 9 LB/TON METAL CHARGED

$$9/0.7 = E_{N_{CO}} = 12.86$$

$$\boxed{E_{N_{CO\,BLAST}} = 12.9 \ \#/\text{TON LEAD}}$$

Since there are no regs for CO, $E_S = E_U$

$$\boxed{E_{S_{CO\,BLAST}} = 207 \ \#/\text{TON LEAD}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/27/74

Source 2° LEAD

from p4 of these calc's

$$\boxed{E_{U_{CO,\ \text{REVERB}}} = E_{N_{CO,\ \text{REVERB}}} = 0}$$

ALSO

$$\boxed{E_{U_{CO,\ \text{POT}}} = E_{N_{CO,\ \text{POT}}} = 0}$$

NOx

(a) Blast Furnace

Employing the same assumption of the gray iron blast furnace parallel,

From Ref ⑦ p 18

$$E_{U_{NO_x,\ \text{BLAST}}} = 0.11\ \#/\text{TON MELT}$$

From p9 of these calc's $\#\text{LEAD}/\#\text{CHARGE} \sim 0.7$

$$E_{U_{NO_x,\ \text{BLAST}}} = .11/.7 = 0.157$$

$$\boxed{E_{U_{NO_x,\ \text{BLAST}}} \sim 0.157\ \#/\text{ton LEAD}}$$

No efforts have been made to control NO_x emissions. As we have done in the past, E_N will be set equal to 0.0 to provide a mechanism of determining the need for control equipment & the relative priority to other sources for which control has also not been demonstrated.

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Computation Sheet For Emission Factors

Calculations Done By ______________________ Date 12/27/74

Source 2° LEAD

$$\boxed{E_{N_{NO_x}}{}_{BLAST} = 0.0}$$

From Ref (84), the gen'l Req't for NO_x limitation for solid fuels (COKE IN THIS CASE) is 0.7 #/10^6 BTU

The heat energy Req'D per ton of lead was not available in the literature directly. However, A MAT'L balance for A "THEORETICAL GRAY iron CUPOLA" IS PRESENTED ON P576 of REF (77). We will use THIS TO DET'N THE HEAT Req'TS (APPROX) TO CONVERT THE REG INTO PROPER UNITS.

268 LB/HR of COKE for 2000 LB/HR of metal output

Ref (101) P 9.5 TAB 9-5 Avg of heating value ≈ 14,000 BTU/LB

$$\frac{268\ \text{LB/HR} \times 14{,}000\ \frac{\text{BTU}}{\text{LB}}}{2000\ \text{LB LEAD/HR}} = 1876\ \frac{\text{BTU}}{\text{LB LEAD}}$$

$$0.7\ \frac{\#\ NO_x}{10^6\ \text{BTU}} \times 1876\ \frac{\text{BTU}}{\text{LB LEAD}} \times \frac{2000\ \text{LB LEAD}}{1\ \text{TON LEAD}} = 2.63\ \text{LB/TON LEAD}$$

Since this is > E_U, $E_S = E_U$

$$\boxed{E_{S_{NO_x}}{}_{BLAST} = 0.157\ \#/\text{TON LEAD}}$$

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Source 2° LEAD

(b) Reverbatory Furnace

Using the grey iron industry analogy

REF ⑦ p18 $E_U = 2.5\ \mathrm{LB}/\mathrm{TON\ MELT}$

From p1 of these calcs

$\#\mathrm{LEAD}/\#\mathrm{charge} = 0.47$

$$EU = 2.5/0.47 = 5.32$$

$$\boxed{EU_{NO_x\ REVERB} = 5.32\ \mathrm{LB}/\mathrm{TON\ LEAD}}$$

As we did for blast furnaces, $E_N = 0.0$

$$\boxed{EN_{NO_x\ REVERB} = 0.0}$$

Since no direct info could be found regarding heat input req'ts for reverb furnaces. We will assume the same as blast furnaces, 1876. BTU/LB LEAD

We will also assume the fuels used are gas & oil & ~~that~~ they are used in a 50/50 proportion.

From Ref (81) the Reg for gaseous fuel is 0.2 #/10^6 BTU & for liquid fuel is 0.3 #/10^6. The Avg is 0.25 LB/10^6 BTU

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Computation Sheet For Emission Factors

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Source 2° LEAD

$$\left(0.25\ \frac{\#}{10^6\ \text{BTU}}\right)\left(1876\ \frac{\text{BTU}}{\#}\right)(2000) = 0.938\ \#/_{\text{LEAD}}^{\text{TON}}$$

$$\boxed{E_{S_{NOx}\ \text{REVERB}} = 0.938\ {}^{\text{LB}}/_{\text{LEAD}}^{\text{TON}}}$$

POT FURNACES

As noted on p 4 of these calcs, "The quantity of air contaminants.... pot furnaces..... is much less than that from reverbatory or blast furnaces" We will assume, ~~therefore~~, that $E_U = E_N = 0$

$$\boxed{E_{U_{NOx}\ \text{POT}} = E_{N_{NOx}\ \text{POT}} = 0}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPER Date 12/27/74

Source 2° LEAD

SUMMARY

	E_U			E_N			E_S			$E_{III(d)}$		
	BLAST	REVERB	POT	BLAST	REVERB	POT	BLAST	REVERB	POT	BLAST	REVERB	POT
PART	271	277	1.36	1.05	1.05	.041	4.35*	6.44*	1.36*	—	—	—
NOx	.157	5.32	Ngl	0.0	0.0	Ngl.	.157	.938	—	—	—	—
SOx	48	212	NEGL.	.48	2.12	NEGL.	46.6	202	—	—	—	—
CO	207	Ngl.	Ngl.	12.9	Ngl.	Ngl.	207	—	—	—	—	—
Pb	171	175	.857	.66	.66	.026	274*	4.06*	.86*	.66	.66	.026

* Existing: For New, ↓

	BLAST	REVERB	POT
PART	1.25	1.25	1.36
Pb	.79	.79	.86

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/10/74

Source Secondary Magnesium

Very little information could be found regarding the secondary magnesium industry.

Ref ⑨⑤ 233.5020A states 2ndary production in 1971 @ 13.42×10^3 tons

"Growth" has been very erratic

For the purpose of this study, we will assume a straight line growth using data (Ref ⑨⑤) from 1964-1971

$$\frac{13.42 - 11.79}{(7)} = 0.233 \times 10^3 \frac{\text{TONS}}{\text{YR}}$$

$$13.42 \times 10^3 + (0.233 \times 10^3)(4) = 1975 \text{ PROD} = 14.35 \times 10^3 \text{ TONS}$$

$$\frac{0.233}{14.35} = 1.6\%$$

$$\boxed{P_c = 1.6\% \quad .016}$$ (simple-MAX)

No direct information regarding "K" could be located other than DOC statistics on capacity utilization rates for "Advanced process non-ferrous metals." The av'g K for 1965-1973 is 82%

$$\boxed{K = 0.82}$$

Ref (144)
P 48, 50
TAB 1 TAB 2

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/16/74

Source Secondary Magnesium

$$A = \frac{14.35\times10^3}{0.82} = 17.5\times10^3$$

$$\boxed{\begin{array}{l} A = 17.5\times10^3 \text{ TONS/yr} \\ \text{or } .0175\times10^6 \text{ TON/yr} \end{array}}$$

WAM 9-27-74

P_B: Ref 037 pg 34 Section 33.2

Asset guideline period = 14 yrs
P_B est → 2×IRS = 28 yrs

$$\frac{100\%}{28\text{ yrs}} \cong 3.5\%/\text{yr} \text{ simple}$$

$$\therefore P_B = .035 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/10/74

Source Secondary Magnesium

Very little information could be found regarding the secondary magnesium industry.

Ref ⑮ p 7.12-1 TAB 7.12-1 gives

$$E_{Up} = 4 \ \#/\text{TON METAL PROCESSED}$$

Since no info could be found on the % recovery of Mg from scrap, we will assume the same as lead. (See calc'n sheet for secondary lead)

$$\frac{\#\ Mg}{\#\ \text{METAL PROCESSED}} = 0.59$$

$$E_{Up} = 4/.59$$

$$\boxed{E_{Up} = 6.78 \ \frac{\#}{\text{TON Mg}}}$$

$$E_{Np} = 0.4/.59$$ same ref

$$\boxed{E_{Np} = 0.68 \ \frac{\#}{\text{TON Mg}}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 12/26/74

Source 2° Mg

Ref (222) pG-29 indicates a typical capacity of about 1 ton

We will assume this to 2000 of feed scrap

Ref (236) pVI-61 indicates a typical cycle is about 8 hours

$$\therefore \text{PWR} = \frac{2000 \text{ LBS}}{8 \text{ hrs}} = 250 \text{ LB/HR}$$

Since we do not have the specific geographical distribution of plants, we will use the gen'l PWR curve generated from Ref's (84) + (148)

$$\text{Allowable} = 0.9 \text{ LB/HR}$$

$$\text{For A FEED/PRODUCT} = 1/.59 = 1.695$$

$$\frac{250}{1.695} = 147.5 \text{ LB/HR} = 0.0738 \text{ TONS/HR Mg}$$

$$Es_{P_{Mg}} = \frac{0.9}{.0738} = 12.2 \text{ \#/TON Mg}$$

Since this is $> E_U$, $E_S = E_U$

$$\boxed{Es_P = 6.78 \text{ LB/TON Mg}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hager Date 12/26/74

Source 2° Mg.

Since no emissions factors could be found for NOx, CO, SOx & HC, we will generate them based on the following assumptions:

(a) Emission factors for NO_x & SO_x & CO for boilers (AP-42)

(b) Heat req'ts based on a typical process weight, consisting of pure Mg. being raised in temperature from 70°F to the melting point through melting & up to the pouring temp.

(c) A heat transfer efficiency = 85%

Although the process is 8 hours in length, the furnace will be operating only 6 hours (Ref (236) p VI-61)

$$Q = \Big[(333\ \text{lb/hr})\Big(Cp_{Mg_{solid}}\ \tfrac{BTU}{lb\,°F}\Big)(T_{melt} - 70°F) + (333)(\lambda_{fu}) + (333)(Cp_{Mg_{liq.}})(T_{pour} - T_{melt})$$
$$+ (SCFM)(60)(\rho_{air})(Cp_{air}) \Big] \div (.85)$$

$T_{melt} = 1200°F$ (Ref. (236) p VI-61)

$T_{pour} = 1500°F$ (Ref (222) p 6-39)

$\rho_{air} = 0.075$

$SCFM = 1100 + 800/2 = 950$ SCFM (Ref (236) p VI-61)

From Ref (101) p 3-118 TAB 3-173

$$Cp_{Mg_s} = \Big[6.20 + .00133T - \frac{67800}{T^2}\Big\} \div MW\ (24.3)$$

$$Cp_{Mg_l} = 7.4 \div MW$$

$$T_{avg._s} = \frac{\left(\frac{70+1200}{2}\right) - 32}{1.8} + 273 = 608\ °K$$

$$T_{avg_l} = \frac{(1200+1500)+2 - 32}{1.8} + 273 = 1005\ °K$$

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Calculations Done By Hopper Date 12/26/74

Source 2° Mg.

$$C_{p_{mg_s}} = \left[6.20 + \underset{.8086}{.00133(608)} - \underset{.1834}{\frac{67800}{608^2}}\right] \div 24.3 = 0.2809 \ \mathrm{BTU/\#°F}$$

$$C_{p_{mg_\ell}} = 7.4/24.3 = .3045 \ \mathrm{BTU/\#°F}$$

Ref (101) p 3-108 TAB 3-169

$$\lambda = \frac{(2160)}{24.3} \times 1.8 = 160 \quad \mathrm{BTU/\#}$$

$$Q = \left[(333)(.2809)(1200-70) + (333)(160) + (333)(.3045)(1500-1200) + (950)(60)(.075)(24)\right] \div .85$$

$$= \left[1.057\times10^5 + 5.328\times10^4 + 3.042\times10^4 + 1.026\times10^3\right] \div .85$$

$$Q = 2.24\times10^5 \ \mathrm{BTU/HR}$$

Ref (236) p VI-61 "Natural gas is usually the heat fuel for the pots."

From Ref (75) p 6.4-2 TAB 6.4-1

NO_x emissions $= 120 \ \mathrm{\#/10^6 FT^3}$

$$E_{V_{NO_x}} = \frac{(2.24\times10^5)(120\times10^{-6})(2000)}{(1050)(147.5)} = 0.347 \ \mathrm{\#NO_x/\frac{TON}{Mg}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/26/74

Source 2° Mg

$$\boxed{Eu_{NO_x} = 0.347 \ \#/\text{TON}_{Mg}}$$

As we have done in the past, E_N will be set = 0.0 to provide a mechanism of determining the need for control equip't & the relative priority to other sources for which control has also not been demonstrated.

$$\boxed{EN_{NO_x} = 0.0}$$

From Ref (54), the gen'l req't for NOx limitation for gas is 0.2 #/10^6 BTU

$$\frac{(0.2)(2.24 \times 10^5)(2000)}{147.5} = 0.607 \ \#/\text{TON}_{Mg}$$

Since this is greater than EU, EU = ES

$$\boxed{Es_{NO_x} = 0.347 \ \#/\text{TON}_{Mg}}$$

CO · Ref ⑮ P 1.4-2 TAB 1.4-1

CO Emission = 20 #/10^6 FT^3

$$Eu_{CO} = \frac{(2.24 \times 10^5)(20 \times 10^{-6})(2000)}{(1050)(147.5)} = 0.0579$$

$$\boxed{Eu_{CO} = 0.0579 \ \#/\text{TON}_{Mg}}$$

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Calculations Done By Hopper Date 12/26/74

Source 2° Mg

Since we also have HC emissions, the use of thermal incineration could be an effective control measure. Assuming an $\eta = 99.9\%$

$$E_{N_{CO}} = (1-.999)(.0579) \approx 0$$

$$\boxed{E_{N_{CO}} = 0}$$

Since there are no Regs for CO, $E_S = E_U$

$$\boxed{E_{S_{CO}} = 0.0579 \text{ \#/ton Mg}}$$

SOx

Ref ⑮ p1.4-2 TAB 1.4-1

$$SO_x \text{ emission} = 0.6 \text{ \#}/10^6 \text{FT}^3$$

$$E_{U_{SO_x}} = \left(\frac{.6}{20}\right)(.0579) = .0017$$

$$\boxed{E_{U_{SO_x}} = 0.0017 \text{ \#/ton Mg}}$$

As we did for NOx, we will set $E_N = 0.0$. Also, it appears that the emissions are too low to be of any consequence.

$$\boxed{E_{N_{SO_x}} = 0.0}$$

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Source 2° Mg

Converting Eu to

$$\frac{(.0017)(147.5)}{(2000)(2.29\times10^5)} = .0006 \ \#/10^6 \text{ BTU}$$

↑ Since this is far less than any State Reg for SO_2, $E_S = E_U$

$$\boxed{E_{S_{SO_2}} = 0.0017 \ \#/\text{ton Mg}}$$

H/C The scrap used in melting furnaces contains organic mat'l which results in the emissions of hydrocarbons during the first part of the operation. No mention of emissions could be found in the literature, however for the purpose of evaluating the emission impact of controls, we will make the following unqualified assumption.

$$1\# \text{ organic mat'l} \Big/ 1000\# \text{ furnace feed}$$

Since the Feed/Product Ratio = 1/.59 = 1.695

$$E_{U_{HC}} = (1.695)(2) = 3.39 \ \#/\text{ton Mg}$$

$$\boxed{E_{U_{HC}} = 3.39 \ \#/\text{ton Mg}}$$

Since we have chosen thermal incineration for CO emissions with an assumed $\eta = 99.9\%$

$$E_{N_{CO}} = (1-.999)(3.39) = 0.0034$$

$$\boxed{E_{N_{CO}} = 0.0034 \ \#/\text{ton Mg}}$$

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Calculations Done By Hopper Date 12/26/74

Source 2° Mg.

Since there are no reg's for H/C $E_S = E_U$

$$\boxed{E_{S_{HC}} = 3.39\ \#/\frac{\text{ton}}{\text{Mg}}}$$

Summary

	E_U	E_N	E_S
Pr	6.78	.68	6.78
NO_x	.347	0.0	.347
SO_x	.0017	0.0	.0017
CO	.058	0	.058
HC	3.39	.0034	3.39

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 1/22/75

Source Steel Foundries

Steel foundries produce steel castings by melting steel metal and pouring it into molds. The melting of steel for castings is accomplished primarily in one of three types of furnaces: direct electric arc, electric induction and open hearth. Specific information regarding the fractional utilization of these furnaces could not be found. We assumed K to be equal to that for the Iron + Steel Industry → 0.90 (See "Industrial Factors, Iron + Steel Industry, p. 12.)

$$\boxed{K = 0.90}$$

The growth rate for the steel foundry industry was assumed to be that for direct electric arc furnaces of the Iron + Steel industry (See "Industrial factors, Iron + Steel Industry, p12) ⟶ .073. Specific information concerning the growth rate for electric induction furnaces could not be found. In addition the open hearth furnace from the Iron + Steel Industry has a negative growth rate, so we assumed its negative growth would be absorbed by the other furnaces.

$$\boxed{P_c = .073_{\text{simple}}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 1/22/75

Source Steel Foundries

Ref 037, p. 34 section 33.0 states that the asset guideline period for the manufacture of primary metals (including assets used in the smelting of ferrous metals) is 18 years. Assuming twice the IRS allowable

$$P_B = \frac{1}{(2)(18)} = .028$$

$$\boxed{P_B = \underset{\text{simple}}{.028}}$$

Ref 236, p. VI-63 indicates there are 400 steel foundries operating in the U.S with plant sizes ranging from 25 to 240 tons/day operating 24 hrs/day, 7 days/wk. for large plants and 8 hrs/day for small plants. We assume the average steel foundry is the average of 25 and 240 $\frac{\text{tons}}{\text{day}}$ or 132.5 $\frac{\text{TONS}}{\text{DAY}}$. Since this reference was dated October, 1971 we assume the data represents 1970 values.

$$Prod_{1970} = 132.5 \frac{\text{TONS}}{\text{Day}} \times 365 \frac{\text{days}}{\text{yr}} \times 400 \text{plants} = 19.3 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$A = \frac{Prod._{1970}}{K}\left(1 + (1975-1970)P_C\right)$$

$$= \frac{19.3 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{0.90}\left(1 + 5(.073)\right) = 29.3 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$\boxed{A = 29.3 \times 10^6 \frac{\text{TONS}}{\text{YR}}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/22/75.

Source Steel foundries

Ref 222$^{\text{p.6-14 table 6.2-3}}$ gives the following table for emission factors of Steel Foundries.

Type of Process	Uncontrolled Emissions ($\frac{lb}{TON}$ processed) Particulate	NOx
Electric Arc Furnace	13	0.2
Open Hearth	11	0.013
Induction Electric	0.1	—

Ref. 222, p. 6-11 also states the following:

Electric induction furnaces are generally small in capacity, usually 1/4 to 1 ton in size. Since open hearth furnaces have a negative growth rate as previously referenced we assume that by 1985 there will be no open hearth furnaces. We also assume that electric induction furnaces contribute only 20% to the total capacity of Steel foundries.

$$E_{u_{P_T}} = (.80)(13\,\tfrac{lbs}{TON}) + (.20)(0.1\,\tfrac{lb}{ton}) = 10.4 + .02 = 10.42\,\tfrac{lbs}{TON}$$

$$\boxed{E_{u_{P_T}} = 10.4\,\tfrac{lbs}{TON}}$$

$$\boxed{E_{u_{NO_x}} = 0.2\,\tfrac{lbs}{TON}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/22/75

Source Steel Foundries

Since the majority of steel foundries utilize either the electric arc furnace or the electric induction furnace and no combustion of fuel is involved we assume there are no hydrocarbon or SO_x emissions.

Ref 222, p.6-14 indicates that a 99% control efficiency can be expected of particulate emissions with the use of a baghouse.

$$E_{N_{Pr}} = (.01) \times \left(10.4 \frac{lbs}{TON}\right) = .104 \frac{lbs}{TON}$$

$$\boxed{E_{N_{Pr}} = .104 \frac{lbs}{TON}}$$

Since there is no available technology for the control of NO_x emissions we assume a 100% control to determine maximum potential impact from control technology

$$\boxed{E_{N_{NO_x}} = 0.00 \frac{lbs}{TON}}$$

E_S

The average process weight rate for a steel foundry is as follows:

$$\frac{\left(132.5 \frac{TONS}{DAY}\right)\left(2000 \frac{lbs}{TON}\right)}{24 \frac{HRS}{DAY}} = 1.1 \times 10^4 \frac{lbs}{hr}$$

We assume the average steel foundry operates 24 hrs/day.

From the general process weight curve Ref 084 & Ref 148 the allowable emissions from an average steel foundry is 12.2 lbs/hr.

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/23/75

Source Steel Foundries

Since no specific information could be found regarding the geographical distribution of steel foundries in the U.S. we assume they are equally distributed among all the states.

$$E_{s_{Pr}} = \frac{\left(12.2 \frac{\text{lbs}}{\text{hr}}\right)\left(24 \frac{\text{hrs}}{\text{day}}\right)}{132.5 \frac{\text{TONS}}{\text{DAY}}} = 2.2 \frac{\text{lbs}}{\text{TON}}$$

$$\boxed{E_{s_{Pr}} = 2.2 \frac{\text{lbs}}{\text{TON}}}$$

Since we assume that all steel foundries will use either an electric arc furnace or an electric induction furnace by 1985 they will not come under any NO_x regulations. Therefore $E_{s_{NO_x}} = E_{u_{NO_x}}$.

$$\boxed{E_{s_{NO_x}} = 0.2 \frac{\text{lbs}}{\text{TON}}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/23/75

Source Steel Foundries

Summary of Emission Factors

	E_u	E_N	E_s
Particulate	10.4 lbs/TON	.104 lbs/TON	2.2 lbs/TON
NO_x	0.2 lbs/TON	0.00 lbs/TON	0.2 lbs/TON
SO_x	—	—	—
Hydrocarbon	—	—	—

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Computation Sheet For Industrial Factors

Calculations Done By Hamer Date 9/10/74

Source Secondary Zinc

Ref ⑨⑤ 233, 6832 PROD 1969 = 376.4x10³ TONS

GROWTH between 1960-1969

$$P_c = \sqrt[9]{\frac{376.4}{265.8}} - 1.0 = 3.94\%$$

$$\boxed{P_c = 3.9\% \text{ COMPOUND}}$$

$$A_{PROD} = 376.4 \times 10^3 (1.039)^6$$

$$A = 473.5 \times 10^3 \text{ TONS}$$

NO INFORMATION COULD BE FOUND FOR K SPECIFICALLY FOR THIS INDUSTRY. WE WILL USE THE CAPACITY UTILIZATION VALUE FOR "ADVANCED PROCESS NON-FERROUS METALS." THE AVERAGE K FOR 1965-1973 WAS 82%

Ref (144)
P48 - TAB 1
P50 - TAB 2

$$\boxed{K = 0.82}$$

$$A = 473.5 \times 10^3 / 0.82$$

$$\boxed{A = 577.4 \times 10^3 \text{ TONS}}$$

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Computation Sheet For Industrial Factors

Calculations Done By ______________________ Date ______________

Source ____

AS A RESULT OF THE APPARENTLY DIFFERENT EMISSION FACTORS FROM THE TWO BASIC ZINC PRODUCING PROCESSES (SWEATING & DISTILLATION), "A" WILL BE DIVIDED ACCORDING TO THE RATIO OF ZINC PRODUCED BY EACH PROCESS.

REF ⑰ p106

IN 1968 233,000 TONS ZN RECOVERED IN DISTILLATION FURNACES

REF (95) 233.6832

IN 1968 354,700 TONS OF SECONDARY ZN

∴ 1968 ZINC BY SWEATING = 354,700 - 233,000 = 121,700

% BY DISTILL = 66 %

% BY SWEAT = 34 %

$$\boxed{A_{\text{SWEAT}} = 196.3 \times 10^3 \ \text{TONS ZN}}$$

$$\boxed{A_{\text{DISTILL}} = 381.1 \times 10^3 \ \text{TONS ZN}}$$

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Computation Sheet For Industrial Factors

Calculations Done By 2J. Marrone Date 9-27-74

Source Secondary Zinc

P_B :

We will assume that the obsolescence rate will be identical for sweating and distillation furnaces and that this factor may be estimate from IRS Tables

Ref 037 pg 34 Section 33.2

Asset guideline period 14 yrs

P_B est = 2×IRS = 28 yrs

$\frac{100\%}{28 \text{ yrs}} \cong 3.5\% / \text{yr}$ simple

$\therefore P_B = .035$ simple

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 9/10/74

Source Secondary Zinc

REF ⑮ p 7.14-2 TAB 7.14-1 PARTICULATES

SWEATING PROCESSES

METALLIC SCRAP – 11 #/TON FROM KETTLE SWEAT FURNACE
– 13 #/TON FROM REVERBERATORY SWEAT FURNACE

AVG = 12 #/TON

Assume the average – 12#/TON

RESIDUAL SCRAP

25#/TON – KETTLE
32#/TON – REVERB

AVG – 28.5#/TON

Assume the average = 28.5#/TON

REF (49) p 406 TAB 19-1 gives 1968 BREAKDOWN

METALLIC –	52,000	TONS	—	30%
RESIDUAL –	119,000	TONS	—	70%
	171,000	TONS		

$$EU_{P_{SWEAT}} = (.3)(12) + .7(28.5) = 3.6 + 19.95 = 23.55$$

$$\boxed{EU_{P_{SWEAT}} = 23.6 \frac{\#}{\text{TON ZN}}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/10/74

Source Secondary Zinc

DISTILLATION FURNACES

REF ⑦⑤ P 7.14-2 TAB 7.14-1

RETORT — 47 #/TON

HORIZONTAL MUFFLE — 45 #/TON AVG = 46 #/TON

$$\boxed{EUP_{DISTIL} = 46 \ \#/\text{TON ZN}}$$

REF ㊾ p135 gives $\eta = 96.3\%$ for baghouse on a sweating furnace

$$EN_{P_{SWEAT}} = 23.6(1-.963) = 0.872$$

$$\boxed{EN_{P_{SWEAT}} = 0.872 \ \#/\text{TON ZN}}$$

Assuming that comparable efficiencies can be obtained on distillation furnaces

$$EN_{P_{DISTIL}} = 46(1-.963) = 1.70 \ \#/\text{TON ZN}$$

$$\boxed{EN_{P_{DISTIL}} = 1.70 \ \#/\text{TON ZN}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoffer Date 9/10/74

Source SECONDARY ZINC

No information could be found on NO_x emissions.

No emission data could be found for CO & HC; however, REF ㊾ p434 STATES CONTROL OF THESE EMISSIONS CAN BE ACHIEVED WITH afterburning OR INCINERATION FOR "combustible MATTER DISCHARGED FROM A low temperature SWEATING FURNACE".

As a gen'l rule, this will result in a controlled emission essentially EQUAL TO ZERO

$$\therefore \boxed{EN_{\substack{CO\\SWEAT}} = 0} \qquad \boxed{EN_{\substack{HC\\SWEAT}} = 0}$$

HOWEVER

$$\boxed{EU_{\substack{CO\\SWEAT}} = ?} \qquad \boxed{EU_{\substack{HC\\SWEAT}} = ?}$$

It can be infered from Ref ㊾ p431 that there are no CO emissions from distillation furnaces due to high temps & thus the oxidation of CO to CO_2

$$\therefore \boxed{EU_{\substack{CO\\DISTILL}} = EN_{\substack{CO\\DISTILL}} = 0}$$

The scrap used in sweating furnaces contains organic materials which results in the emission of hydrocarbons. However, the zinc charged to distillation furnaces is "relatively pure" by comparison. We will, therefore, assume

$$\boxed{EN_{\substack{HC\\DISTILL}} = EU_{\substack{HC\\DISTILL}} = 0}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/11/74

Source Secondary Zinc

Summary:

	E_N		E_U	
	DISTILL	SWEAT	DISTILL	SWEAT
Pt	1.70	0.872	16.0	23.6
CO	0	[0]	0	?
HC	0	[0]	0	?
NO_x				

See p 12 of these Calcs for an updated Summary

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Computation Sheet For Emission Factors

Calculations Done By U F Russo Date 10/29/74

Source Secondary Zinc

Ref. 157 gives gives the number of establishments in the 2ndary Zinc Industry as 17 plants in 1967.*
Assuming the # plants are in same ratio as production i.e. assume same average capacity

Sweating

$$\text{Outpt Process Wgt Rate} = \frac{A_{sweating}\,(\text{lbs/YR})}{.34\,(1+P_c)^8\,N_p\,(8760\ \text{HRS/YEAR})}$$

$$= \frac{(196.3\times10^3)(2000)}{.34\,(1+.039)^8\,(8760)\,N_p}$$

$$\cong \frac{97066}{17}\ \text{lbs/HR}$$

$$\cong 5700\ \text{lbs/HR}$$

Assuming the same input wgt./output wgt. relationship as for secondary copper sweating

$$\text{Input Process Wgt Rate} = \left(\frac{38,400}{64,000}\right)^{-1}(5700)\ \text{lbs/HR}$$

$$= 9515\ \text{lbs/HR}$$

* Plants in 2ndary non-ferrous industry's were apportioned according to 1967 production

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Computation Sheet For Emission Factors

Calculations Done By W.F. Russo Date 10/29/74

Source Secondary Zinc.

Using the 50 State Average Process Wgt. Rate, the allowable Emissions are

Allowable Emissions = 11.0 lbs Part/HR

Thus.

$$E_S^{sweating} = \frac{11.0 \text{ lbs Part/HR}}{5700 \text{ lbs/HR}} \; 2000 \text{ lbs/TON}$$

$$\boxed{E_S^{sweating} = 3.86 \text{ lbs Part / TON 2ndary Zinc}}$$

Distillation Furnaces.

Assuming input wgt/output wgt. relationship is same as for copper blast furnaces.

Input Process Wgt. Rate = 15,830 lbs/HR

Using 50 state average:

Allowable Emissions = 15.0 lbs Part/HR

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Computation Sheet For Emission Factors

Calculations Done By Russell Date 10/29/74

Source 2° ZN

Thus

$$E_S^{\text{Dist.}} = \frac{15.0 \text{ lbs Part}/\text{HR} \quad 2000 \text{ lbs}/\text{TON}}{11{,}080 \text{ lbs}/\text{HR}}$$

$$\boxed{E_S^{\text{Dist.}} = 2.71 \text{ lbs Part}/\text{Ton 2}^{\text{nd}}\text{ary Zinc}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/24/74

Source 2° Zinc

Since no emission factors could be located for gaseous emissions, we will generate them based on the following assumptions:

(a) Emission factors for NO_x, CO for boilers (AP-42)
(b) Heat req'ts based on a typical pour consisting of pure Zn being raised in temperature from 70°F to the melting point, through melting & up to the pouring temperature
(c) A heat transfer efficiency = 85%

Ref (157) gives the No. of 2° Zn establishments = 17 (1967)

$$1969 = 1967\,(1+.039)^2$$

$$\frac{376.4\times10^3}{(1.039)^2} = 1967 \text{ Prod.} = 348.7\times10^3 \text{ tons}$$

$$\frac{348.7\times10^3}{17} = 20{,}510 \ \frac{\text{tons}}{\text{yr}\cdot\text{plant}}$$

From Ref (236) pVI-66, a single operation lasts from 10-12 hrs
Assume ∴, # hours operation per year = 8760/2 = 4380 hrs.

$$\frac{20{,}510 \text{ tons Zn}\,(2000)}{4380 \text{ hrs}} = 9365 \ \#/\text{hr}$$ Ref (236) same page talks of a 19,000 lb/hr plant; so, this value appears reasonable.

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/24/74

Source 2° ZINC

From Ref ㊾ p 406 TAB 19-1 gives 1968 scrap input
@ 171,000 TONS (sweating)

From p2 of these calculations 1968 production (sweating)
= 121,700 TONS

$$\frac{\text{FEED}}{\text{PRODUCT}} = \frac{171{,}000}{121{,}700} = 1.405$$

$$\text{INPUT} = (1.405)(9365) = 13{,}157 \text{ LB/HR}$$

$$\begin{aligned}\text{HEAT REQ'T} = {} & \left(13{,}157 \tfrac{\text{LB}}{\text{HR}}\right)\left(Cp_{ZN_{\text{SOLID}}} \tfrac{\text{BTU}}{\text{LB °F}}\right)\left(T_{MELT} - 70°F\right) + (13{,}157)(\lambda_{ZN}) \\ & + (13{,}157)\left(Cp_{ZN_{\text{LIQUID}}}\right)\left(T_{POUR} - T_{MELT}\right) \\ & + (SCFM)(60)(\rho_{AIR})(Cp_{AIR}) \div 0.85\end{aligned}$$

From Ref ㉓⑥ p II-66 SCFM = 20-30 PER LB/HR (Assume 25)

$(13{,}157)(25) \approx 329{,}000$ SCFM

$Cp_{AIR} = 0.24$ BTU/LB-°F

$\rho = 0.075$ LB/FT³

$$\left.\begin{array}{l} T_{MELT} \approx 800°F \\ T_{POUR} \approx 1100°F \end{array}\right\} \text{Ref (236) p II-66}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/26/74

Source 2° Zinc

Ref (101) P 3-122 TAB 3-173

$$Cp_{ZN_S} = 5.25 + .00270\ T°K \div mw \quad (65.4)$$

$$Cp_{ZN_L} = 7.59 + .00055\ T°K \div mw$$

$$T_{avg_S} = \frac{(70° + 800°F) - 32}{1.8} + 273 = 738°K$$

$$T_{Avg_l} = \frac{(800 + 1100) - 32}{1.8} + 273 = 1311°K$$

$$Cp_{ZN_S} = .1107\ BTU/\#°F$$

$$Cp_{ZN_l} = .1271\ BTU/\#°F$$

$$\lambda = 1595\ \frac{cal}{mole}$$

Ref (101)
P 3-109
TAB 3-169

$$\lambda = \frac{1595}{65.4} \times 1.8 = 43.9\ BTU/\#$$

$$Q = \Big[(13{,}157)(.1107)(800-70) + (13157)(43.9) + (13157)(.1271)(1100-800) + (329{,}000)(60)(.075)(.24)\Big] \div .85$$

$$= \Big[1.063 \times 10^6 + .578 \times 10^6 + .502 \times 10^6 + .355 \times 10^6\Big] \div .85$$

$$Q = 2.94 \times 10^6\ BTU/HR$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/26/74

Source 2° Zinc

Ref (244) p II-6 indicates primary fuels are natural gas + oil & "the fuel used most is natural gas". We will assume 100% to simplify the calc's..

NOx

From Ref (75) p 1.4-2 TAB 1.4-1

NO_x emissions = $120^{\#}/10^6 FT^3$

$$\frac{2.94 \times 10^6 \frac{BTU}{HR}}{1050 \frac{BTU}{FT^3}} = 2800 \ FT^3/HR$$

Ref (75) p 1.4-1

$$\left(2800 \frac{FT^3}{HR}\right)\left(120 \times 10^{6} \frac{\#}{FT^3}\right) = .336 \ \#/HR$$

$$EU_{NO_x} = \frac{(0.336)(2000)}{(9365)} = 0.0718 \ \frac{\# NO_x}{TON \ Zn}$$

$$\boxed{EU_{NO_x \ SWEAT} = 0.0718 \ \#/\frac{TON}{Zn}}$$

Assume the same for distillation

$$\boxed{EU_{NO_x \ DIST.} = 0.0718 \ \#/\frac{TON}{Zn}}$$

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Calculations Done By Hopper Date 12/26/74

Source 2° Zinc

As we have done in the past, E_N will be set = 0.0 to provide a mechanism of determining THE NEED for CONTROL equip't + the RELATIVE PRIORITY TO OTHER SOURCES FOR WHICH CONTROL HAS ALSO NOT BEEN DEMONSTRATED

$$\boxed{E_{N_{\substack{NO_x\\ \text{SWEAT}}}} = 0.0}$$

$$\boxed{E_{N_{\substack{NO_x\\ \text{DISTILL.}}}} = 0.0}$$

From Ref ㉔ the gen'l req't for NO_x limitation for gas is 0.2 #/10^6 BTU

$$\frac{0.2\ \text{\#}/10^6\text{BTU} \times 294\times10^6\ \frac{\text{BTU}}{\text{HR}} \times 2000}{9365} = 0.126\ \text{\#}/\text{TON ZN}$$

Since this is greater than E_U, $E_U = E_S$

$$\boxed{E_{S_{\substack{NO_x\\ \text{SWEAT}}}} = 0.0718\ \text{\#}/\frac{\text{TON}}{\text{ZN}}}$$

$$\boxed{E_{S_{\substack{NO_x\\ \text{DISTILL}}}} = 0.0718\ \text{\#}/\frac{\text{TON}}{\text{ZN}}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

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Source 2° Zinc

CO

Ref (75) p 1.4-2 TAB 1.4-1

CO Emission = 20 #/10⁶ ft³

$$E_{U_{CO}} = \frac{(2800)(20\times10^{-6})(2000)}{9365} = 0.012$$

$$\boxed{E_{U_{CO\ SWEAT}} = 0.012\ \#/\text{ton ZN}}$$

p 8 of these calcs discusses the use of incineration to control combustible matter from a sweating furnace

Assuming an $\eta = 99.9\%$

$$E_{N_{CO}} = 0.012(1-.999) \approx 0.0$$

$$\boxed{E_{N_{CO\ SWEAT}} = 0}$$

Since there are no regs. for CO, $E_U = E_S$

$$\boxed{E_{S_{CO\ SWEAT}} = 0.012\ \#/\text{ton ZN}}$$

H/C The scrap used in sweating furnaces contains organic mat'ls which results in the emission of hydrocarbons. No mention of emissions could be found in the literature.

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Source 2° Zinc

For the purpose of evaluating the emission impact, we will make the following unqualified assumption

$1^{\#}$ HYDROCARBON / 1000 # FEED MAT'L = 2 #/TON FEED

Since the feed/product ratio = 1.405

$$EU_{\substack{HC \\ SWEAT}} = 2^{\#}/\frac{TON}{FEED} \times 1.405 \frac{TON\ FEED}{TON\ Zn} = 281$$

$$\boxed{EU_{\substack{HC \\ SWEAT}} = 281\ \#/\frac{TON}{Zn}}$$

Since we are using incineration with an assumed $\eta = 99.9\%$

$$EU_{\substack{HC \\ SWEAT}} = 2.81\left(1-.999\right) = 0.0028$$

$$\boxed{EN_{\substack{HC \\ SWEAT}} = 0.0028\ \#/\frac{TON}{Zn}}$$

Since there are no H/C Regs $E_S = E_U$

$$\boxed{ES_{\substack{HC \\ SWEAT}} = .291\ \#/\frac{TON}{Zn}}$$

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Source 2° Zn

Summary

	Eu		En		Es	
	Distill.	Sweat	Distill	Sweat	Distill	Sweat
Pt	46.0	23.6	1.70	.872	2.71	3.86
CO	—	.012	—	0	—	.012
HC	—	2.81	—	.0028		2.81
NOx	.0718	.0718	0.0	0.0	.0718	.0718

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